Ontario

FRUIT PRODUCTION

Recommendations

2004-2005

Publication 360

MINISTRY OF AGRICULTURE AND FOOD

Discard old editions of this publication. Each year the appropriate sub-committee of the Ontario Pest Management Research and Services Committee reviews the pesticide products listed in this publication. To the best knowledge of the committee, at the time of printing, the pesticide products listed in this publication were:

- federally registered
- classified by the Ministry of the Environment as of November 2003.

The information in this publication is general information only. The Ministry of Agriculture and Food does not offer any warranty or guarantee, nor does it assume any liability for any crop loss, animal loss, health, safety or environmental hazard caused by the use of a pesticide mentioned in this publication.

This publication lists a number of brand names of pesticides. It is neither an endorsement of the product nor a suggestion that similar products are ineffective.

The Pesticide Label

Consult each product label before you use a pesticide. The label provides specific information on how to use the product safely, hazards, restrictions on use, compatibility with other products, the effect of environmental conditions, etc.

The pesticide product label is a legal document. It is against the law to use the product in any other way.

Federal Registration of Pesticide Products

The Pest Management Regulatory Agency (PMRA) of Health Canada registers pesticide products for use in Canada based on an evaluation of scientific data to ensure that the product has merit and value; and the human health and environmental risks associated with its proposed use are acceptable.

1. Full Registration

Pesticide registrations are normally granted for a period of five years, subject to renewal.

2. Temporary Registration

Temporary registration may be granted for a period not to exceed one year, where the registrant agrees to produce additional scientific or technical information, or the pesticide is used for emergency control of a serious pest outbreak.

Maximum Residue Limits

Health Canada has established maximum residue limits (MRLs) for pesticides. Processors or retailers may demand more restrictive limits. Growers should seek advice of their intended market to determine if more restrictive limitations apply. Keep accurate and up-to-date records on pesticide use in each crop.

Supplemental Labels

You MUST obtain a supplemental label and follow all the label directions when PMRA approves new uses for a registered pesticide that do not appear on the current label.

Examples of when you must use a supplemental label include:

- **Temporary Registrations for Emergency Use**
- **Minor Use Label Expansion**

You can obtain a copy of a supplemental label from the pesticide manufacturer or pesticide vendor, the grower association that sponsored the emergency registration or minor use, from OMAF or PMRA's Pest Management Information Service.

For more information on the federal registration status check the PMRA web site at *www.hc-sc.gc.ca/pmra-arla* or call 1-800-267-6315.

Regulation of Pesticides in Ontario

The Ministry of the Environment is responsible for regulating pesticide sale, use, transportation, storage and disposal in Ontario. Ontario regulates pesticides by placing appropriate education, licensing and/or permit requirements on their use, under the *Pesticides Act* and Regulation 914.

All pesticides must be used in accordance with requirements under the *Pesticides Act* and Regulation 914. The *Act* and Regulation are available on the e-laws web site at *www.e-laws.gov.on.ca* or call Publications Ontario Toll-Free number: 1-800-668-9938 or 416-326-5300.

Classification of Pesticides

The Ontario Pesticides Advisory Committee (OPAC) is responsible for reviewing and recommending to the Ministry of the Environment, the placement of pesticide products into one of six schedules used to control sale and use. Once approved by the Ministry of the Environment, classified products are posted on the OPAC web site: *www.opac.gov.on.ca*. For more information call OPAC at (416) 314-9230.

Certification and Licensing

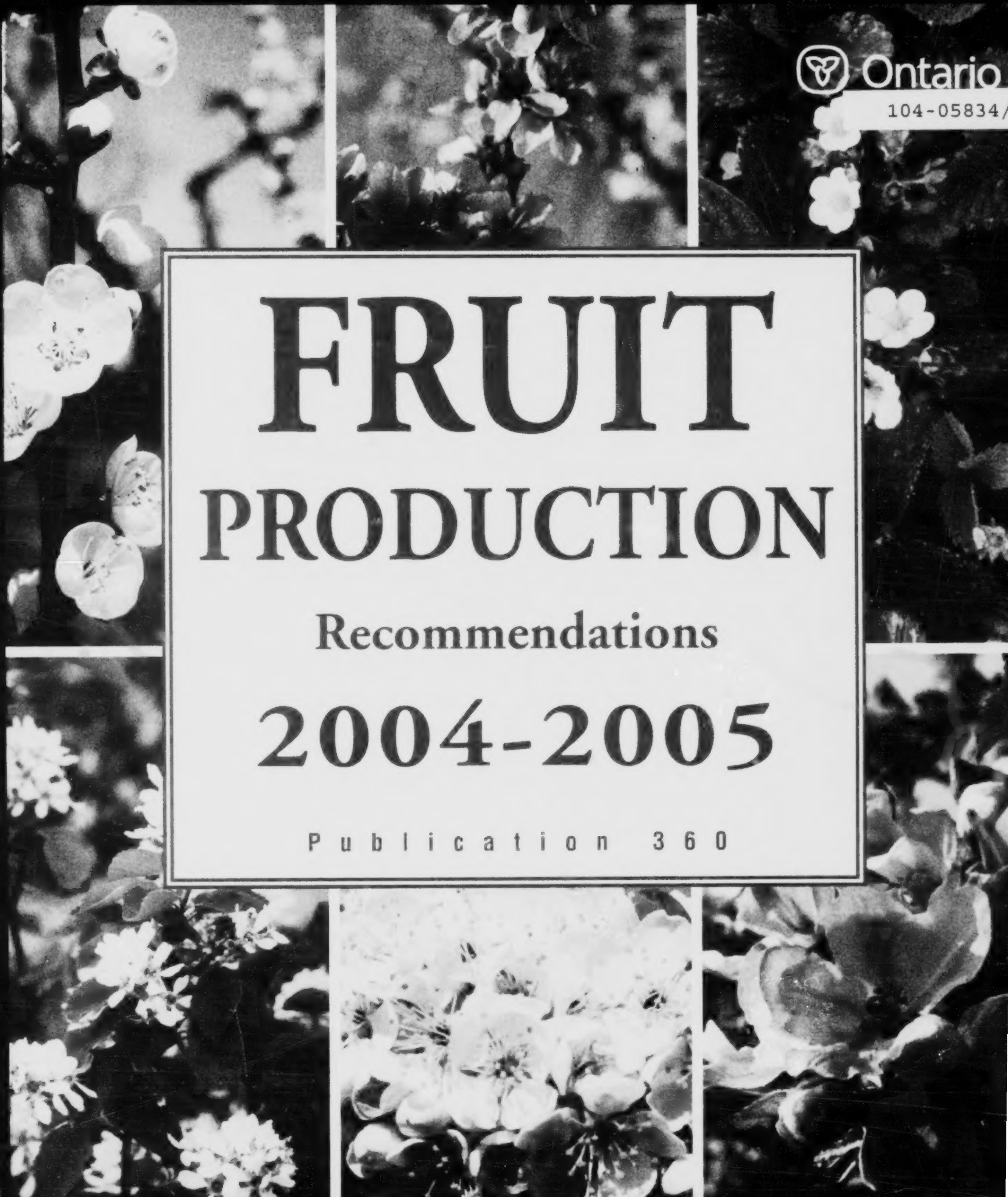
Growers and their Assistants

For information about certification for growers and training for assistants check the Ontario Pesticide Education Program web site: *www.ridgetownc.uoguelph.ca/opep/* or call 1-800-652-8573.

Commercial Applicators and their Assistants

For information about exterminator certification and licensing and technician training check the Ontario Pesticide Training & Certification web site *www.ridgetownc.uoguelph.ca/optc* or call 1-888-620-9999.

Cette publication est aussi disponible en français.



Ontario

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Need technical or business information?

**Contact the Agricultural Information Contact Centre at:
1-877-424-1300 or ag.info@omaf.gov.on.ca**

Looking for fruit production recommendations on the Internet?

www.omaf.gov.on.ca
It's one-stop shopping for Factsheets, articles and photos regarding the production and maintenance of Ontario's fruit crops.
(or call us at 1-888-466-2372 to receive by fax/e-mail)

Acknowledgements

The recommendations contained in this publication have been prepared in consultation with:

- Ontario Pest Management Research & Services Committee
- Ontario Pesticide Education Program
- Ontario Horticultural Research & Services Committee
- Ontario Soil Management Research & Services Committee

and personnel of:

- Crop Technology, OMAF
- CropLife Canada
- University of Guelph
- Brock University CCOVI
- Ontario Ministry of the Environment
- Agriculture and Agri-Food Canada
- several private consulting businesses

Illustrations recreated, with permission, from the following publications:

- *Berry Production Guide for Commercial Growers*, 2000-2001 Edition
  Ministry of Agriculture, B.C., Lower Mainland Horticulture Improvement Association, 2000
- *Midwest Small Fruit Pest Management Handbook*
  Ohio State University Extension, Columbus, OH, 1997
- *Midwest Tree Fruit Pest Management Handbook*
  University of Kentucky Cooperative Extension Service, Lexington, KY, 1998

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1. Precautions with Pesticides

Pesticide Regulations

You must report all major spills, fires or thefts involving pesticides to the Ontario Ministry of the Environment at 1-800-268-6060. (Regulation 914, s. 29)

Pesticide schedules in Ontario

The Ontario Pesticide Advisory Committee is responsible for reviewing and recommending the placement of pesticide products into one of six schedules used to control the sale and use of pesticides. See Table 1–1, *Pesticide schedules*. For a list of pesticides in this publication, and the classification by schedule, see Table 12–1, *Pesticides used on fruit crops in Ontario*, on page 217.

Certification and training requirements

You must be a certified grower or a licensed exterminator to buy and use Schedule 1, 2 or 5 pesticides. Assistants may also use these pesticides if they are trained and supervised as required.

Pesticide certification for Ontario farmers

Regulation 914 of the *Pesticides Act* requires that agriculturalists (growers) be certified to buy and use Schedules 1, 2 or 5 pesticides on land they farm. To become certified, agriculturalists must:

- attend the Grower Pesticide Safety Course (GPSC) and successfully complete the examination, and
- meet the definition of an "agriculturalist" as defined by Regulation 914 under the *Pesticides Act* (i.e., use farmland for agricultural or forestry production that falls within the farmlands property class under section 7 of the *Ontario Assessments Act*), and
- be at least 16 years of age.

Training for agricultural assistants using schedule 2 or 5 pesticides

All assistants must have formal pesticide safety training, recognized by the Ministry of the Environment, before they can handle or use Schedule 2 or 5 pesticides under the supervision of a certified grower.

- This applies to all assistants, including family members, farm employees and seasonal workers.
- Trained assistants do not have to write an exam.
- Trained assistants must be 16 years of age or older.

TABLE 1–1. Pesticide schedules

Sch.	Who Can Use It	Pesticide Characteristics
1	• licensed exterminator • certified grower • only with approved permit	• very toxic • very persistent • highly mobile
5	• licensed exterminator • certified grower • assistant agriculturist under supervision	• very toxic • very persistent • highly mobile • less toxic or less persistent alternative not available
2	• licensed exterminator • certified grower • trainee or technician under supervision (some restrictions apply) • assistant agriculturist under supervision	• toxic • persistent • moderately mobile
3	• licensed exterminator • certified grower • trainee or technician • consumer	• moderately toxic • moderately persistent • slightly mobile
4	• licensed exterminator • certified grower • trainee or technician • consumer	• low toxicity • non-persistent • non-mobile • containers < 1 kg < 1 L
6	• licensed exterminator • certified grower • trainee or technician • consumer	• low toxicity • non-persistent • non-mobile • containers > 1 kg > l L

There are two training options for assistants. Assistants can:

- attend a Grower Pesticide Safety Course and not write the certification examination, or
- attend an on-farm training session presented by a qualified trained assistant instructor.

For more information and a listing of Grower Pesticide Safety Course session dates and locations, check the Ontario Pesticide Education Program web site at *www.ridgetownc.uoguelph.ca/opep/*.

To register for a Grower Pesticide Safety Course anywhere in Ontario, or for information about trained assistants:

- call: 1-800-652-8573
- fax: (519) 674-1589
- e-mail: *opep@ridgetownc.uoguelph.ca*.

Certification and licensing for commercial pesticide applicators and exterminators

For updates to training requirements under Regulation 914 of the *Pesticides Act*, refer to the Ministry of the Environment web site at *www.ene.gov.on.ca* or phone 1-888-565-4923.

To apply pesticides as a business, you must be a licensed exterminator.

This includes farmers who custom-apply pesticides for other farmers and charge a fee for this service. Licensed exterminators who are self-employed must hold an operator license as well as the appropriate exterminator license. Exterminator licenses are valid for 5 years.

To become a licensed exterminator, you must:

- complete a home study course and certification exam through Ridgetown College, University of Guelph, **and**
- send proof of certification (letter of successful completion of the exam(s)) and a fee to the Ministry of the Environment to obtain your exterminator license.

Training for technicians working as assistants to licensed exterminators

Assistants to licensed exterminators must become technicians to mix, load or apply all Schedule 3, 4 and 6 pesticides and most Schedule 2 pesticides (some restrictions apply), under the indirect supervision of a licensed exterminator. Technicians cannot mix, load or apply Schedule 1 or 5 pesticides. Technician cards are valid for 2 years.

To become a technician, you must:

- complete an MOE-approved academic course and exam, and
- complete practical training with a licensed exterminator.

For more information about certification and licensing requirements for licensed exterminators and training for technicians, contact Ontario Pesticide Training & Certification:

- tel: 1-888-620-9999
- fax: (519) 674-1585
- web site: *www.ridgetownc.uoguelph.ca/optc*.

General Precautions

Always read the label:

- **Before you buy a pesticide!**
- **Before you begin to use a pesticide!**
- **Before you store a pesticide or dispose of it!**

Learn about the health hazards and toxic properties of the pesticide you are using. Consult the product label, Material Safety Data Sheet (MSDS) or manufacturer for this information. Check the company web sites for MSDS information. (See Table 12–5, *Pest control product companies*, on page 227.)

Protect yourself when using pesticides

- **Make sure someone knows** where you are working, what pesticides you are handling and how long you expect the job to take.
- **Post emergency numbers**, including the Poison Information Centre and Spills Action Centre, near all of your telephones.
- **Keep a list of the names and the *Pest Control Products (PCP) Act* registration numbers** of all the pesticides you handle. Keep a file of the pesticide label booklets for all the products you use. Make sure your co-workers and family members know where this list or file is in case of an accident.
- **Have plenty of clean water, soap and paper towels — and an extra set of gloves and coveralls — nearby at all times** in case pesticide contaminates your clothing or skin.

- **Wear the correct protective clothing and equipment, and be sure that all items are clean and in good repair** before you put them on.
- **Never smoke, chew tobacco, eat or drink when you handle pesticides.** Never carry tobacco or food in your clothes — and never leave tobacco, food or beverages in areas where you handle or store pesticides.
- **Change your clothes and wash your hands and face before you eat, drink or smoke.**
- **Wash your hands before you use the toilet, as well as after.** The skin in your groin area absorbs pesticides very easily.

Protect other people, livestock, pets, water and sensitive crops

- Buy and store only what you need.
- Prevent drift.
- Keep pesticides out of water.
- Clean up spills quickly and safely.
- Dispose of containers and waste pesticide safely.

Protect bystanders

Take precautions to prevent exposure of bystanders to pesticides.

- Post notices in public areas stating where treatments are planned or have occurred. For specific information on applying pesticides to public lands, refer to the Ontario *Pesticides Act*, Regulation 914, at *www.e-laws.gov.on.ca*.
- Remove all objects from the area where pesticides will be applied.
- Avoid spraying areas near public roadways where school children may be present.
- Advise owners or occupants on private land what precautions they may take to prevent exposure, such as staying off the sprayed area for 24 hours.

Preventing accidental release of pesticides

- Keep spray equipment (power hoses, backpacks, etc.) safely stored in a locked compartment when not in use and during transport.
- Be prepared to handle pesticide spills and other emergencies. Have a pesticide spill kit and emergency phone numbers readily available.
- Never dispose of pesticides, empty containers or excess mixed pesticide on the property or leave them behind.

Human Health

Risks of pesticide use

Each time you handle a pesticide, you are at some risk. The amount of risk depends on two things — the toxicity of that pesticide and your exposure to it.

Risk = Toxicity x Exposure

Toxicity

Toxicity is a measure of how harmful or poisonous the pesticide is. There are 2 types of toxicity:

- **Acute toxicity** — the toxic response that results from a **single exposure** to the pesticide. The symbols and words on the front panel of a pesticide label give you information about the acute toxicity.

  Lethal dose 50% (LD_{50}) is a measure of acute toxicity. It is the dose (mg of product per kg of body weight) that will kill 50% of the test animals within a stated time period (24 hours to 7 days). Those products with low LD_{50} ratings are highly toxic.

  Table 1–2, *Relative acute toxicity of pesticides*, on page 4, lists products in this publication according to the relative acute toxicity and warning symbol on the label.

- **Chronic toxicity** — the toxic response that results from repeated exposures to small doses of a pesticide over a longer time period. These toxic effects may not appear for months or years after exposure to the pesticide. The symbols on the label do NOT give information about the chronic toxicity of the product. Use protective clothing and equipment to help reduce exposure and the risk of chronic effects.

Cholinesterase blood tests

Organophosphate and carbamate pesticides can affect your nervous system. These pesticides can change your serum and red blood cell levels of an enzyme called acetyl cholinesterase. Your body uses this enzyme to transmit messages through your nervous system.

TABLE 1–2. Relative acute toxicity of pesticides

Use this table as a guide, but refer to the product label for specific information. Information about specific hazards such as corrosiveness, and skin or eye irritations are not included in this table but can be found on the product label.

DANGER SYMBOL High Acute Toxicity	**WARNING SYMBOL** Moderate Acute Toxicity	**CAUTION SYMBOL** Lower Acute Toxicity	
Carzol SP	Agri-Mek 1.9 EC	Admire	Lime Sulphur
Decis 5 EC	Assail 70 WP	Aliette WDG	Maestro 80 DF
Diazinon 500E	Busan 1020	Apollo SC	Malathion 25W
Diazinon 50W	Copper 53W	Bioprotec CAF	Manzate 200 WP
Endosulfan 50W	Copper Spray	Botran 75W	Manzate 200 DF
Furadan 480F	Cygon 480–Ag	Bravo 500	Mertect SC
Guthion SC	Cymbush 250 EC	Cabrio EG	Microscopic Wettable Sulphur
Guthion Solupak	Lagon 480E	Captan 80 WDG	Nova 40 W
Imidan 50 WP	Mitac W	Confirm 240F	Nustar
Lannate	Pyramite	Dikar	Pennocozeb 75 DF
Lorsban 50 W	Sevin XLR Plus	Dipel 2X DF	Polyram DF
Matador 120 EC	Vapam	Dithane DG	Ridomil Gold 480 EC
Pirimor 50 DF	Zinc phosphide (Rodent pellets)	Elevate 50 WDG	Ridomil Gold Mz 68 WP
Pounce		Equal 65 WP	Ripcord 400 EC
Sniper		Ferbam 76 WDG	Ronilan EG
Telone C-17		Flint 50 WG	Rovral
Telone II		Folpan 50 W	Senator 70 WP
Thiodan 4 EC		Foray 48BA	Sovran
Thiodan 50 WP		Funginex 190EC	Streptomycin 17
Thionex 50 WP		Gavel 75 DF	Success 480SC
Vydate L		Indar 75WSP	Topas 250 EC
Zolone Flo		Kelthane 50 W	Vangard 75 WG
		Kumulus DF	
		Lance WDG	

TABLE 1–3. Pesticides that affect cholinesterase levels in blood

Product name	Active ingredient
Carzol SP	formetanate hydrochloride
Cygon 480–Ag	dimethoate
Diazinon 50 W	diazinon
Diazinon 500 E	diazinon
Furadan 480 F	carbofuran
Guthion SC	azinphosmethyl
Guthion Solupak	azinphosmethyl
Imidan 50 W	phosmet
Lagon 480 E	dimethoate
Lannate	methomyl
Lorsban 50 W	chlorpyrifos
Malathion 25 W	malathion
Pirimor 50 WP	pirimicarb
Sevin XLR Plus	carbaryl
Sniper	azinphos methyl
Vydate L	oxamyl
Zolone Flo	phosalone

If your cholinesterase levels fall, you can experience symptoms, including trembling, twitching, blurred vision, difficulty breathing and heart difficulties.

If you use any of the pesticides listed below on a regular basis, you should have regular cholinesterase blood tests. See Table 1-3, *Pesticides that affect cholinesterase levels in blood*. Your family doctor can arrange these tests, and they are covered by OHIP. **Have your first test before you begin to handle these pesticides**. That will show the baseline (normal) cholinesterase level for your body. During the spray season, if you are spraying organophosphorus or carbamate insecticides regularly for several weeks, you should have a cholinesterase blood test every **7–10 days**. If your cholinesterase level drops to below one-half of your baseline level, then you are showing signs of pesticide poisoning and **you must remove yourself from exposure** to these pesticides until your cholinesterase level returns to normal.

Exposure

Exposure is a measure of the contact you have with the pesticide. You can be exposed to the pesticide in 3 ways.

- **Dermal exposure** occurs through skin or eyes. The amount and rate of pesticide that may be absorbed depends on several things, including:
  - **skin condition. If your skin is moist, or if you have rashes, broken skin or scratches, pesticide will be absorbed more easily**
  - the part of your body exposed. Eyes, genital area, scalp and ear canals absorb pesticides at a higher rate than hands or arms. Eyes absorb pesticides at a rate of 100%.
- **Respiratory exposure** (inhalation) occurs when you inhale small spray particles, dust, gases or vapours.
- **Oral exposure** occurs when a pesticide enters your mouth or you swallow a pesticide.

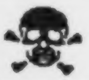
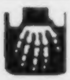
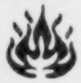
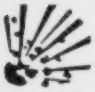
Pesticide Label Information

Check the label for special warnings about eye and skin hazards.

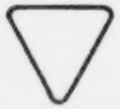
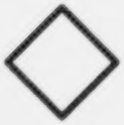
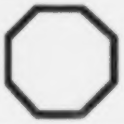
The front panel of the pesticide label may also contain warnings that the product is corrosive to eyes, or is a skin or eye irritant.

Learn these symbols and words — they could save your life!

Four important symbols and words show the potential hazards of pesticides.

Hazard Symbol	Signal Word
	Poison
	Corrosive
	Flammable
	Explosive

The hazard symbol always appears inside one of the following shapes. These shapes and their warning words tell the degree of hazard of the pesticide. **The more sides to the shape, the more hazardous the product.**

	Warning Symbol	Signal Word
Triangular shape means low hazard (3 sides)		Caution
Diamond shape means moderate hazard (4 sides)		Warning
Octagonal shape means high hazard (8 sides)		Danger

Re-entry periods

The re-entry period is the minimum time that must pass between when the pesticide was applied and when workers can enter the crop area without wearing personal protective equipment. Entering fields too early without wearing protective equipment after pesticides have been applied may expose workers to poisoning. Such poisoning can result from handling treated plants or from inhaling pesticide vapours.

Table 1–4, *Re-entry periods for pesticides used on fruit crops,* on page 6 shows specific minimum intervals you must observe between applying the pesticide and working in the treated crop without protective equipment.

- Some pesticides, like Mitac W, have labels that carry a warning about working in treated crops. Follow the label recommendations.
- Do not enter treated areas without protective equipment until the suggested time has passed.
- Use this table as a guide, but refer to the product label for specific information.
- If no re-entry period is stated on the label, assume that the spray solution must be dry before re-entry can occur.

Days to harvest (preharvest) intervals, pregrazing and feeding intervals

These intervals state the minimum time that must pass between the last pesticide application and the harvesting of the crop, or the grazing or cutting of the crop for livestock feed. If you harvest a crop before the preharvest interval has passed, there may be pesticide residues in excess of the Maximum Residue Limits (MRL)

TABLE 1–4. Re-entry periods for pesticides used on fruit crops

Minimum interval before re-entry	Product trade name	Special comments. See label for details
4 hours	Elevate 50 WDG	
	Lance WDG	
12 hours	Assail 70 WP	
	Flint 50 WG	12 hours for apples and pears, except 4 days for hand thinning longer for grapes (5–12 days)
	Indar 75WSP	
	Success 480 SC	longer interval (14 days) for thinning, summer pruning
	Nustar	
	Ridomil Gold MZ	
	Rovral	
24 hours	Admire	
	Cabrio EG	strawberries longer for blueberries (29 days) and stone fruit (10 days)
	Lannate	
	Matador120 EC	
	Penncozeb 75 DF	
	Pirimor 50 DF	
	Pyramite	
	Zolone Flo	
48 hours	Bravo 500	less for certain tasks
	Supra Captan 80 WDG	48–72 hours depending on the crop
	Dikar	see label for special precautions
	Furadan 480 F	
	Gavel 75 DF	
	Maestro 80 DF	48–72 hours depending on the crop
	Vangard 75 WG	48–72 hours depending on crop
	Vydate	
72 hours	Supra Captan 80 WDG	48–72 hours depending on the crop
	Maestro 80 DF	48–72 hours depending on the crop
	Ronilan	less with protective clothing
	Topas 250 EC	less with protective clothing
	Vangard 75 WG	48–72 hours depending on crop
4 days	Lorsban 50W	for peaches. Less for other crops on label
5 days	Flint 50WG	for grapes, except 12 days for girdling
7 days	Sovran	less for certain tasks with protection
	Streptomycin 17	less for certain tasks with protection
Greater than 7 days	Cabrio EG	10 days for stone fruit 29 days for blueberries
	Flint 50 WG	12 days for girdling grapes
	Guthion Solupak, Guthion SC	28 days for grapes 7 days for raspberries 14 days for tree fruits, except 15 days for cherries
	Mitac W	see label precautions
	Sniper	see Guthion

set by Health Canada. When crops with persistent residues are fed to livestock, the pesticides may poison the animal or may contaminate the milk or meat.

To avoid exceeding the Maximum Residue Limits, always follow the label.

The days to harvest intervals for products used in this publication are listed in Table 12–4, *Number of days from last spray to harvest*, on page 224. This information is also listed at the end of the pest control calendar for each crop.

Crop rotation statements

Some pesticides can persist in treated soil and crops sensitive to that pesticide may be injured if planted too soon after the treated crop is harvested. Some labels state a minimum waiting time that must pass before it is safe to plant sensitive crops.

Total number of applications

Some product labels state the total number of applications of that pesticide that can be made during a growing season. These limits prevent food residues, crop damage, soil residues or pest resistance.

Emergency Procedures for Pesticide Poisoning and First Aid Information
See inside back cover.

Protective Clothing and Equipment

Make sure the protective clothing and equipment:

- is what is needed for the job
- fits properly, and
- is clean and in good repair and working condition.

The protective clothing and equipment needed depends on:

- the pesticide being used — Read the precautions section of the label to know what to wear.
- the job you are doing — For example, more protection is needed when handling concentrated pesticide or when mixing and loading a sprayer.
- the type of application — For example, enclosed space or air-blast sprayer applications made with open tractors require more equipment.

Each person working with pesticides needs his or her own set of protective clothing and equipment. Consult the technical expert at your safety supply company to ensure that you purchase appropriate and properly fitting equipment.

For **ALL** pesticides, always wear:

- **A water-repellent hat, such as a hard hat or waterproof rain hat. Do not wear hats made from cloth.** Baseball-style caps absorb pesticides and are not safe. If you need to protect your entire head and neck — when applying pesticides in a greenhouse, dusty formulations or using an air-blast sprayer — wear a hood or hat that protects the ear canals.
- **Long pants and a shirt with long sleeves or a coverall.** Coveralls can be reusable or disposable. Reusable coveralls are normally cotton or polyester and should be tightly woven. Designate disposable coveralls for pesticide use. Use water-resistant coveralls because cotton, denim and cotton/polyester pants cling to the skin when wet, increasing the risk of dermal exposure.
- **Chemical-resistant gloves** (unlined). Use neoprene or nitrile gloves (PVC), unless the label states otherwise. Do not wear rubber gloves, as many pesticides can break down the rubber material. Wear your gloves under your sleeves with the top cuffed.
- **Chemical-resistant boots** (unlined). Wear your pant legs over your boots to prevent pesticide from running down inside your boots.

Read the label. It will describe what extra protective clothing and equipment to wear. For some pesticides you may also need to wear:

- Goggles. Use safety goggles with indirect vents so that splashes do not enter your eye. Regular eye glasses do not provide complete protection. Never wear contact lenses when handling pesticides.
- Face shield
- Chemical-resistant apron
- Respirator

A respirator is a unit that covers the mouth and nose to prevent spray droplets, small particles and vapours from getting into the lungs. **A dust mask is not a substitute for a pesticide respirator.** Make sure you use cartridges and pre-filters that protect against organic vapours. For more information about respirators, refer to the Grower Pesticide Safety Course Manual, Ridgetown College, University of Guelph.

Extra protection, such as canister gas masks or a self-contained breathing apparatus (SCBA) may be needed when applying:

- any pesticide in an enclosed area
- fumigants, gases, vapours or smokes.

ALWAYS wear a respirator when working with fumigants, gases or vapours, or when applying any pesticide in an enclosed area.

When spraying using a tractor with a cab, use tractor cab cartridges, which work the same way as an air-purifying respirator. These cartridges and prefilters must be replaced and maintained regularly to provide continued protection.

When using air-blast sprayers, mist blowers and tractors without cabs, wear the appropriate:

- respirator
- waterproof suit
- head covering
- chemical-resistant gloves
- boots
- eye protection.

Do not operate the tractor without wearing protective clothing and equipment, unless it has been decontaminated.

Safety supply companies

Consult safety supply companies for help in selecting protective clothing and equipment. See Table 1–5, *Safety supply companies in Ontario providing protective clothing and equipment*, on page 9.

Care of protective clothing and equipment

- Clean all protective clothing and equipment when the spray operation is finished.
- Never let children, pets or livestock come in contact with contaminated clothing or equipment. Also ensure they cannot come into contact with the puddles of water left over from cleaning equipment.
- Wash gloves with soap and water, and leave them on to remove other protective clothing and equipment.
- Always remove protective clothing and equipment outdoors. If a granular pesticide was used, shake the clothing outdoors in a safe place, emptying pockets and cuffs.
- Throw out clothing contaminated by spills of highly toxic or concentrated pesticide. Place clothing in a plastic bag and take to a landfill site.
- Coveralls and other spray clothing must be washed separately from other clothes. Wash after each use. Place in a plastic bag and keep separate. Wash protective equipment with hands still protected by gloves. It is best to wash equipment outdoors. If you do not have an outside clean-up area, keep certain buckets just for equipment clean-up. Mark and keep them in a special place. Wash the inside and outside of goggles, hat, boots and any water-repellent clothing in warm, soapy water, rinse well and let them air-dry.
- Remove cartridges and prefilters from the respirator.
- Discard cartridges, canisters and filter pads when breathing becomes difficult, or when you notice a pesticide taste or odour, or at the interval set by the manufacturer.
- Make a note of the date the cartridge is first used.
- Remove cartridges and filter pads from the face piece and store in clean, sealed plastic bags.
- Wash the face piece in warm soapy water, rinse thoroughly and dry in a well-ventilated area. Air-drying prevents damage to the inlet and outlet valves.
- Never use alcohol or other solvents for cleaning, as they damage the rubber and plastic.
- Next, wash the outside of boots and gloves with soapy water; then remove them.
- After removing boots and gloves, wash them inside and out with detergent and water, rinse thoroughly and dry in a well-ventilated area.
- Place all dry articles in a clean storage area until next use.

How to wash your spraying clothes

- Never mix spray clothing with household laundry. Store and wash all clothing used for spraying separately from other clothing. Wash after each use. Remember to use chemical-resistant gloves to handle pesticide-contaminated clothing.

TABLE 1–5. Safety supply companies in Ontario providing protective clothing and equipment

3-M Canada Company	Occupational Health and Environmental Safety Box 5757 London, ON N6A 4T1	(519) 452-6165 1-800-364-3577 fax: (519) 452-4660
Acklands Grainger	90 W. Beaver Creek Rd. Richmond Hill, ON L4B 1E7	(905) 731-5516 1-800-668-8989 fax: (905) 731-2798
Aearo Canada	6889 Rexwood Rd. Mississauga, ON L4V 1R2	(905) 795-0700 1-800-387-4304 fax: (905) 564-5250
Dutch Industries "Protect-Air Cab Filter"	Huron Tractor, Box 1300 Exeter, ON N0M 1S3	(519) 235-1115 fax: (519) 235-1939
HAMISCO	3392 Wonderland Rd. London, ON N6L 1A8	(519) 652-9800 1-800-668-9800 fax: (519) 652-9661
Dupont Personal Protection	20 Ryan Place Brantford, ON N3S 7S1	(519) 752-4369 1-800-387-9326 fax: (519)752-2161
Levitt-Safety (Eastern) Limited	2872 Bristol Circle Oakville, ON L6H 5T5	(905) 829-3299 1-800-668-6153 fax: (905) 829-2919
MSA Canada	2800 Skymark Ave., Unit 33 Mississauga, ON L4W 5A6	(905) 602-0338 1-800-267-0672 fax: (905) 238-4151
Mitt & Robe Co. Ltd.	751 Norfolk St. N. Simcoe, ON N3Y 3R6	(519) 428-4050 1-877-893-6565 fax: (519) 428-5142
Plant Products Co. Ltd.	314 Orenda Rd. Brampton, ON L6T 1G1	(905) 793-7000 1-800-387-2449 fax: (905) 793-9632
Safety Express	4060B Sladeview Cres. Unit 2 Mississauga, ON L5L 5Y5	(905) 608-0111 1-800-465-3898 fax: (905) 608-0091
The St. George Company (Suppliers of Kasco Helmets)	P.O. Box 430 20 Consolidated Dr. Paris, ON N3L 3T5	(519) 442-2046 1-800-461-4299 fax: (519) 442-7191

- Presoak clothing before washing. Use one of 3 methods:
  - hose off garments outdoors
  - soak in separate tub or pail
  - use the prewash cycle in an automatic washer.
- Place the clothing directly into the washing machine. Wash only a few garments at a time. Do not wash with other family clothes.
- Use hot water, the highest water level and the longest cycle, with heavy-duty detergent. Wash as you would for heavily soiled clothing.
- Wash clothing again.
- After washing, hang outside (preferably in bright sunlight) until completely dry. Do not use the clothes dryer.
- Clean the washing machine. Run the washing machine through one complete cycle using only detergent and hot water (without clothing).

Personal hygiene

- Always wash your hands before eating, drinking or smoking.
- When finished for the day, bathe or shower as soon as possible. The longer a pesticide remains on the skin, the greater the risk that it will be absorbed into the body.

- Wash your hair and under your fingernails. Shower with lots of soap and water.
- Always change into clean clothes.
- Wear clean work clothes every day. A small spill on the previous day's clothes may seem unimportant, but wearing the same clothing again without washing it prolongs the exposure and increases risk.

Protect the Environment

Prevent contamination of adjacent land and water bodies

- Do not allow pesticides to drift, runoff or leach onto land or water bodies bordering treatment areas. Leave a suitable buffer zone between the treatment area and adjacent areas.
- *Buffer zones* are areas left untreated to protect an adjacent area, aquatic system or natural habitat.

  Aquatic systems include lakes, reservoirs, streams, creeks, ditches, marshes, wetlands, ponds, well heads, commercial fish ponds, etc.

  Natural habitats include hedgerows, grasslands, shelterbelts, windbreaks, woodlots, vegetative strips, etc.
- Do not spray right to the edge of aquatic systems or natural habitats. Leave an untreated area of natural vegetation to protect these areas. Some pesticide labels tell you to leave a buffer zone when spraying, others do not. See Table 1–6, *Examples of buffer zones for pesticides used in Publication 360*. In the absence of guidelines on the label, take the necessary precautions to prevent pesticide drift into aquatic systems and wildlife habitat. Leave at least a 15 metre buffer strip between the pesticide treatment area and aquatic systems. Do not spray when wind speeds are high or gusty, regardless of the buffer zone.

Protect adjacent land

No spray droplets should fall on adjacent properties, where treatments are not authorized. Areas of concern are:

- cultivated plants grown for human consumption
- plants sensitive to herbicide drift
- trees or shrubs that may be damaged by herbicides leaching to roots
- areas where children play.

TABLE 1–6. Examples of buffer zones for pesticides used in Publication 360

Product	Buffer zone for aquatic systems	Buffer zone for natural habitat
Admire	boom sprayer: 15 m	
	air-blast sprayer: 40 m	
Agri-mek 1.9%EC	35 m	
Aliette WDG	8 m	
Assail 70 WP	boom sprayer: 20 m	boom sprayer: 2 m
	air-blast sprayer: 30 m	air-blast sprayer: 10 m
Bravo 500	15 m	
Cabrio EG	boom sprayer: 31 m	boom sprayer: 2 m
	air-blast sprayer: 42 m	air-blast sprayer: 2 m
Confirm 240 F	air-blast sprayer: 15 m	
Cymbush 250 EC	15 m	
Decis 5EC	15 m	
Elevate 50 WDG	7 m	
Flint 50 WG	boom sprayer: 10 m	
	air-blast sprayer: early season – 17 m late season – 9 m	air-blast sprayer: 1 m
Gavel 75 DF	boom sprayer: 25 m	boom sprayer: 5 m
	air-blast sprayer: 35 m	air-blast sprayer: 10 m
Lance WDG	air-blast sprayer: early season – 5 m late season – 2 m	air-blast sprayer: early season – 5 m late season – 2 m
Matador 120 EC	boom sprayer: 15 m	
	air-blast sprayer: 80 m	
Mitac W	air-blast sprayer: 100 m	
Nova 40 W	15 m	
Nustar	5 m	
Pounce	15 m	
Pyramite	air-blast sprayer: 49 m	
Ripcord 400 EC	15 m	
Ronilan EG	15 m	
Sovran	7 m	3 m
Success 480 SC	air-blast sprayer: early season – 2 m late season – 1 m	

Use this table for general guidelines, but always refer to the label for product-specific information.
Buffer zones for aerial application are not included in this table, but may be present on the label.

Protect water sources

- Use an anti-backflow device to prevent back-siphoning when drawing water from wells, ponds, streams or other sources.

- Mix pesticide and load the sprayer away from any water supply, including wells, ponds or streams.
- Use buffer zones (untreated areas) when applying pesticides to avoid contaminating surface water, wells, ponds and/or streams, especially those containing fish. Check the product label for specific buffer zone distances. See *Setback distances for water bodies*, below.
- Do not allow equipment rinse water and excess pesticides to run into sewers or ditches with water in them. Put rinse water into spray tanks and apply to the treatment area. Otherwise, it must be disposed of as hazardous waste through a hazardous waste disposal company. For more information, see *Disposal of pesticides and empty pesticide containers*, below.
- Blow or sweep granular pesticides off driveways and hard surfaces, back into the turf, to prevent them from contaminating storm sewers.

Setback Distances for Water Bodies

It is an offence under the federal *Fisheries Act* to introduce any material into water that may be harmful to fish or fish habitat. To protect these waters, applicators must determine a suitable setback distance between the area to be protected and the area where pesticide treatments are planned. The protected area includes the water body as well as adjacent riparian (riverbank) areas that contribute to fish food and habitat. See Table Table 1–6, *Examples of buffer zones for pesticides used in Publication 360*, on page 10.

Reduce and manage pesticide spray drift

- Read the product label for information regarding buffer zones, water volumes and recommended nozzles.
- Use buffer zones around all watercourses and wells and neighbouring fields that contain sensitive crops. If the label does not state a specific buffer zone distance, leave an untreated area of natural vegetation.
- Select the recommended sprayer application rate (L/ha).
- Select the correct nozzle. Where practical, use air induction/venturi nozzles. These nozzles significantly reduce drift when compared to conventional nozzles.
- Select the correct nozzle-to-target distance.
- Spray only when winds are light to moderate (11 km/hr or less). If drift is occurring because of the wind, **stop spraying** until the wind subsides. Do not apply pesticides if the wind is blowing towards susceptible crops or environmentally sensitive areas such as watercourses.
- Use spray plume protection where practical or available (hoods, shrouds, screens and air curtains).
- Use drift-reducing adjuvants in the spray tank as directed by the label.
- Utilize wick weeders, instead of spraying, when possible.
- Use non-volatile compounds.

For more information about spray drift, see the OMAF/Agriculture and Agri-Food Canada booklet *BMP 13, Best Management Practices — Pesticide Storage, Handling and Application* (Appendix I, *Best Management Practices Booklets and Ordering Information*, on page 242) and the Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift* and *Spray Drift Reduction Through Air Induction*.

Prevent bee poisoning

See *Bee Poisoning* on page 64, for recommendations on preventing bee poisoning. See Table 6–1, *Relative toxicity of pesticides to honeybees*, on page 66.

Disposal of pesticides and empty pesticide containers

Triple or jet rinsing containers

Unrinsed pesticide containers are not really "empty." They may still hold about 1% of the original amount of pesticide. Although this figure sounds low, it is still a hazard to humans, animals and the environment. To reduce the hazard, rinse each container 3 times as the spray tank is filling. Use either the manual triple rinse technique or a specially designed device for rinsing containers. Paper or cardboard containers are often strong enough to be rinsed. If it is possible, rinse these containers as well as plastic ones.

To triple rinse:

1. Fill the empty container at least 10% full of the diluting material (usually water).
2. Cap, then shake or roll the container so that the inside surfaces of the container are well rinsed.
3. Pour rinsings into the spray tank.
4. Repeat steps 1–3 twice more.

Remember to check the container after rinsing. Make sure no pesticide has been left behind as a cake or paste on the bottom of the container.

Rinsing devices use pressurized water to clean out the container. They are just as effective as triple rinsing but take less time. Follow the manufacturer's instructions.

Disposal of empty containers

Never re-use empty pesticide containers. They may be handy, but there is still some risk, even if the containers are triple rinsed. Never give empty, rinsed containers to anyone, especially not children. Dispose of them promptly.

Regulation 914 of the *Pesticides Act* regulates how pesticide containers are to be disposed of in Ontario (Reg. 914, s. 27).

Metal, plastic or glass containers: An empty metal, plastic or glass container that has been used to hold a Schedule 1, 2, 3*, 5 or 6* (*non-domestic) pesticide shall be disposed of by:

- triple rinsing or jet rinsing using clean water, or another appropriate solvent

AND either

- taking it for recycling to a Pesticide Container Depot

OR

- taking it to a licensed waste disposal site.

Once containers are properly rinsed, puncture them to make it impossible to use again and to ensure the rinse water is out of the container.

It is often more convenient to store empty, rinsed containers until you have collected enough to make a trip to the recycling Pesticide Container Depot or the waste disposal site. If storing containers, keep them in a dry safe place, such as the storage area, until you can dispose of them properly.

Recycling: The Ontario Pesticide Container Recycling Program is available to growers and commercial exterminators. Through this program, **clean, triple-rinsed, plastic/metal pesticide containers** (up to 23 L in size for plastic and 20 L in size for metal) can be returned to Pesticide Container Depots located throughout the province. To locate the Pesticide Container Recycling Depot closest to you, call the Ontario Pesticide Education Program at 1-800-652-8573.

Paper and cardboard containers: A paper or cardboard container that has been used to hold a Schedule 1, 2, 3*, 5 or 6* (*non-domestic) pesticide shall be disposed of by:

- triple rinsing or jet rinsing (if possible) using clean water;

AND either

- burning (if allowed by municipal bylaws), in circumstances that persons and animals are kept out of any smoke produced and any smoke is directed away from buildings, highways, roads or outdoor areas frequented by the public

OR

- taking it to a licensed waste disposal site.

Paper or cardboard containers are often rigid enough to withstand rinsing. If possible, triple rinse these containers as you fill the tank. Then burn the containers in an isolated area on the farm.

Be very careful around the smoke. It may contain toxic fumes from the burning pesticide. Be certain there is no chance a person or animal may breathe in this smoke. Make sure the smoke does not drift toward buildings, roads or any public outdoor areas.

These containers can also be taken to a local waste disposal site as for metal, plastic or glass containers. If you cannot dispose of them immediately, make sure containers are kept in a secure place such as the pesticide storage area.

Unwanted pesticides

Be sure to dispose of unneeded pesticides safely.

- Contact the supplier. It is sometimes possible to return unused pesticide if it is still in its original container.
- If you cannot find any way to use the product as shown on the label, then the Ministry of the Environment requires that waste be disposed of by licensed waste haulers to a licensed waste disposal site. Look in the Yellow Pages under "Liquid Waste Removal."

- Watch your local paper for "Municipal Hazardous Waste Collection Days" or contact your municipality. If your municipality has no waste collection days, encourage it to sponsor such an event. On these days, you can turn over surplus pesticide concentrates (maximum 25 L) for disposal.

Surplus spray mix

The best way to dispose of any excess spray mix is to find other fields that require an application of this pesticide. Before spraying, check the label to make sure the pesticide is registered for use on that crop.

If you cannot find another field to spray, then dilute the remaining spray mix by adding 10 parts of water for each 1 part of spray mix. This diluted solution can be safely applied to the treated area as long as you do not exceed the pesticide rate recommended on the label. Be sure to check the label for any restrictions about crop rotation, days to harvest or surplus spray mix disposal.

NEVER respray the treated field with undiluted spray mix. Spraying an area twice will double the recommended pesticide rate. This may cause illegal pesticide residues in the harvested crop or harmful residues in the soil that can cause crop damage.

Storing pesticides

Ontario's *Pesticides Act* and Regulation 914 give storage requirements for storage facilities. The storage requirements that must be followed depends on which schedules of pesticides that you store. See Table 1–7, *Pesticides Act storage requirements*. See also the OMAF Factsheet, *Pesticide Handling Facilities*, Order No. 94-037.

Pesticide spills

Protect yourself before beginning to clean up any spill. Clean up spills immediately.

In the case of **minor** spills:

- For liquids, cover the spill with a thick layer of absorbent material such as kitty litter, vermiculite or dry soil. Sweep or shovel the material into a waste drum.
- For powders and granulars, sweep or shovel the material into a waste drum.

TABLE 1–7. *Pesticides Act* storage requirements

	Schedule		
	3, 4, 6	2	1, 5
No contact with food or drink	✓	✓	✓
Does not impair health/safety	✓	✓	✓
Clean and orderly manner	✓	✓	✓
Warning signs posted on storage buildings	✓	✓	✓
Warning signs posted on unattended vehicles	✓	✓	✓
Emergency telephone numbers posted		✓	✓
Ventilated to outside		✓	✓
Limited access (locked)		✓	✓
No floor drain		✓	✓
Safety equipment available		✓	✓
Area used exclusively for pesticides			✓

In the case of a **major** spill:

- Remove any people or animals from the spill area.
- Stop the spill from spreading.
- Do not let the pesticide enter any watercourse.

If a pesticide spill causes, or is likely to cause, an adverse effect, you must notify the Ministry of the Environment Spills Action Centre at 1-800-268-6060 (24 hours a day, 7 days a week) and your municipality.

For information on preventing spills, see the OMAF Factsheet, *Ways to Avoid Pesticide Spills*, Order No. 96-025.

Emergency Procedures for Pesticide Poisoning and First Aid Information
See inside back cover.

2. Pesticide Application

Sprayers for Fruit Crops

Various types of sprayers are used for applying pesticides to fruit crops. These include hand-held sprayers, boom sprayers, and air blast or mist sprayers. When selecting the best sprayer for pesticide application consider:

- **Crop type and acreage**: Row crops, vineyards or orchards require different types of sprayers to ensure good coverage of the pesticide. The sprayer must be able to penetrate the crop canopy as it changes over the growing season and throughout the life of the planting. The type of sprayer chosen also depends on the type of pesticide used (herbicides, insecticides and fungicides).
- **Sprayer capacity**: You must be able to cover the acreage in the time available.
- **Performance in adverse conditions**: Does the spraying equipment allow spraying in higher winds without excessive drift (e.g., hooded booms, guide vanes, air assist, etc.).

Always apply pesticides correctly. Incorrect application can waste pesticide, compromise control, damage crops (possibly a neighbour's) and contaminate the environment. New equipment and control systems can make pesticide application simple and precise.

- Calibrate the sprayer at least twice during the growing season with each set of nozzles used. The wear on nozzles and other parts alters the amount of spray delivered.
- Check all nozzles for flow rate at least once a year. Replace nozzles when their output is 10% greater than rated output.
- Adequate agitation is essential when applying wettable powder formulations.
- Make sure pumps are capable of delivering the flow and pressure required, and are compatible with materials sprayed.
- Look at product labels for recommended volumes, pressures, nozzle types, angles and spacing.
- Keep in mind that the higher the pressure, the greater the danger of drift to other crops.
- If 2,4-D or related herbicides are used, clean the sprayer thoroughly with detergent containing ammonia to prevent crop damage from herbicide residue.

Sprayers for small plantings

Hand-held 9–14 L knapsack or garden sprayers are used in small plantings and for spot treatments. Most are operated with compressed air that is supplied by a hand pump. The disadvantages of hand-operated sprayers are that pressure and output rates vary. Also, they do not provide enough agitation to keep wettable powders in suspension. Where uniform coverage is important, do not apply insecticides and fungicides with low-pressure sprayers without pressure regulators.

Some back-pack sprayers have diaphragm pumps and agitators and are suitable for wettable powders. Pressures should be above 80 psi. However, avoid excessively high pressures that produce smaller spray droplets that, in light winds, can drift to susceptible garden plants.

- Use a separate sprayer for herbicides.
- Never apply azinphosmethyl or other highly toxic insecticides with a hand-held sprayer.

Field sprayers

- Use boom-type sprayers for field pesticide applications. These sprayers apply pesticides evenly across the width of the boom. To spray fields effectively, always maintain:
  - uniform spray pressure
  - constant forward speed
  - stable boom height (to ensure uniform overlap of the nozzle tip patterns)
  - appropriate application rates (L/ha) depending on the pesticide used.
- For row crops such as strawberries, apply insecticides and fungicides using boom sprayers with

water volumes of about 300–1,000 L/ha (120–400 L/acre). Herbicide applications range from 50–1,000 L/ha (20–400 L/acre). Refer to the product label for specific volume instructions.

- Flat fan nozzles provide uniform distribution on an even surface. They are best used on boom-type sprayers for herbicide application.
- Hollow cone nozzles are generally used to apply fungicides or insecticides. This type of nozzle produces a finer and more uniform spray than a solid cone. Hollow cones are particularly suited to the application of wettable powders, flowables, and suspensions.
- Solid cones are used when increased penetration into the crop canopy is required.

For information on boom sprayers used for weed control, and herbicide application, see the latest edition of OMAF Publication 75, *Guide to Weed Control*.

Air-blast or mist sprayers

Air-blast sprayers use a combination of air and liquid to deliver the pesticide to the target. The pesticide is pumped through nozzles into a blast of air from a high-speed fan. The pesticide is broken into fine droplets and carried in air currents to the target. These sprayers can be adjusted to apply high or low volumes of spray at a wide range of pressures. Mechanical agitation is required in the spray tank. Drift can be a problem with the fine spray produced by these sprayers.

- Use air-blast sprayers for spraying insecticides and fungicides on tree fruit, bushberry and bramble (raspberry) crops.
- **Never use air-blast or mist sprayers to apply herbicides.** They can cause herbicidal damage far from the target treatment area.

Aerial Application by Airplane or Helicopter

Any person who applies pesticide from an aircraft in Ontario **must** hold an aerial exterminator licence. In addition, a permit is required to purchase and apply pesticides by air for the following:

- applications to surface water, e.g., ponds, lakes, rivers (exceptions in some cases)
- applications to forests as defined in the *Crown Forest Sustainability Act*
- applications of any Schedule 1 or 5 pesticide or a Schedule 2 pesticide containing 2,4-D, 2,4-DB, mecoprop, MCPA, MCPB, dichlorprop, dicamba, picloram, paraquat or trichlopyr except when applications are made to agricultural land.

Be sure that any pesticide applied by air has specific instructions for aerial use on the label.

Take extra precautions when using insecticides that are toxic to honeybees, such as Sevin (carbaryl).

Weather Considerations for Spraying

Air temperature and relative humidity

If applied in very hot weather (above 27°C), pesticides can cause phytotoxicicty, or burning of leaves and flowers.

Avoid spraying between 10 a.m. and 2 p.m. in hot sunny weather as plants are prone to injury at this time. The spray water droplets can act as tiny magnifying glasses and cause plant injury. As well, due to hot, dry air, a large portion of spray droplets may evaporate before they hit the target.

When relative humidity is high, drying of spray solution may be delayed. Prolonged and slow drying of pesticides can lead to phytoxicity in some instances.

Pyrethroid insecticides (Ripcord, Matador, Cymbush, Pounce) break down more quickly in hot weather (above 27°C) and are therefore less effective. If possible, choose other products in hot weather or apply these insecticides in the evening when temperatures have dropped.

Cold weather can also make plants more susceptible to spray injury. Frost can damage the leaf cuticle, allowing pesticides to enter the leaf and cause burning. Do not apply pesticides, especially oil-based pesticides, for a 1 or 2 days following frost injury. Oil sprays applied to tree fruit just prior to frost can make buds more susceptible to frost injury.

Plants growing in prolonged cool, cloudy weather conditions develop very thin cuticles and are more susceptible to phytotoxicity and injury from pesticides.

Rainfall

The decision to spray just before or shortly after a rain is based on the need for plant protection. Timing with respect to rainfall is critical when applying fungicides.

- Apply protectant fungicides before rain and in time for the fungicide to dry. However, in the absence of adequate fungicide residue before a rain, some fungicides can be applied shortly after a wetting period and will provide after-infection activity. Waiting for rain to stop before applying fungicides may allow plant disease to establish. However, pesticides applied in the rain are much more prone to washing off and will be effective for a shorter time period. Once dry, most fungicides can withstand approximately 2.5 cm of rainfall and still provide adequate protection.

Windspeed and drift

When applying fungicides and insecticides, light to moderate air movement helps move the product in and around the crop. Light winds also help the drying process. Optimum air movement is 3–8 km/hr.

- To prevent unwanted drift, avoid spraying when windspeed is more than 11 km/hr. Drift is also possible at lower wind speeds and depends on travel speed, wind speed and droplet size.

- If drift is occurring due to wind, stop spraying until the wind subsides.

- Do not apply pesticides if the wind is blowing towards susceptible crops or environmentally sensitive habitat.

Other resources

Reducing Pesticide Drift and Crop Damage: OMAF Factsheet Order No. 88-118

Best Management Practices: *Pesticide Storage, Handling and Application*, BMP 13 and *Integrated Pest Management*, BMP 09. See Appendix I, *Best Management Practices Booklets and Ordering Information*, on page 242 for ordering information.

Ontario Pesticide Education Program (Ridgetown College) videos *How to Manage Spray Drift and Spray Drift Reduction Through Air Induction*.

Pesticide Application

Using water correctly

- Mix pesticides with clean water that does not contain debris, sand or mud.

- Never let the water intake screen rest on a pond bottom when filling a sprayer.

- The water intake line near the screen must, by law, have a check valve or anti-backflow device. This prevents water-source contamination when the pump is shut off.

- Do not use a tank-refilling nozzle, volume-booster nozzle, or injection pump when refilling sprayer tanks from ponds or streams. These tank-refilling aids may contaminate the water source.

- When using a farm water supply, install a frost-free water hydrant outside the building. Place an anti-backflow valve/siphon preventor on the discharge end of the hydrant.

Agitation

Every sprayer must have agitation to keep the spray material well mixed. If there is too little agitation, the pesticide will be applied unevenly. If there is too much agitation the pesticide may foam and clog the pump or nozzle. The type of agitation required depends on the pesticide formulation used. There are 3 main types of agitation: mechanical, hydraulic and air sparging.

Mechanical agitation is produced by paddles attached to a shaft mounted near the bottom of the spray tank. This type of agitation assures proper mixing for all liquid spray formulations.

Hydraulic agitation occurs when a portion of the pump output is returned to the tank. To be effective:

- the return or bypass line from the pressure regulator must deliver liquid to the tank bottom
- it should return 2–14 L/min. to the tank when applying chemical formulations in solution
- it should return 14–27 L/min. for each 450 L of tank capacity when spraying wettable powders. The appropriate rate depends on the wettable powder concentration and size of the tank. A dedicated line from the pressure side of the pump (not the pressure regulator) to the tank must be used to carry the liquid necessary for hydraulic agitation. Always use a venturi jet or sparge tube. Sparge tubes need more water than venturis to provide

the same agitation. You can reduce the flow rate if the sprayer tank has a mechanical agitator.

Air sparging is agitation caused by bubbling air through the liquid. A compressor supplies air that is discharged from a sprayer tube in the bottom of the tank. As the bubbles of air rise to the surface, they create turbulence that keeps the fluid well mixed.

Preparing a wettable powder and oil or emulsifiable concentrate mix

To prepare a tank-mix of wettable powder and an oil or emulsifiable concentrate, follow these steps unless the product label states differently:

1. Fill the sprayer tank with water to the half full mark.
2. Start the agitator.
3. Add a premixed slurry of wettable powder and water.
4. Agitate for 2 minutes before adding more water.
5. Add the oil or emulsifiable concentrate last.
6. Do not over-agitate the mixture. It may become a grease-like mass that settles to the tank bottom. Over-agitation may also cause the mixture to foam excessively.
7. After any break from spraying, agitate the tank thoroughly before resuming.
8. To prevent oil buildup in the sprayer, empty the tank completely before refilling.
9. Clean the tank and sprayer with a detergent or solvent immediately after use, then flush thoroughly with clean water.

Soluble packaging options

Choose soluble packages that dissolve in the spray tank to reduce container disposal. Water-soluble packaging is used for dry flowable and wettable powder formulations of pesticides and is available under names such as Clean Pak, Solupak, and Toss-N-Go. In most cases, the water-soluble packaging material is PVA (poly vinyl alcohol). This material dissolves completely when added to the water in the sprayer tank according to instructions.

- Read all labels and instructions carefully. For more details contact your vendor.
- Keep soluble pouches dry until you add them to the spray tank.
- Do not handle pouches with wet hands or wet gloves.
- Do not remove pouches from the outer package until you are ready to add them.
- Always reseal the outer package to protect the remaining pouches from moisture.

Mixing soluble pouches

- Consult product labels for specific mixing instructions for each product.
- Fill the spray tank $^1/_2$ full of water and have the agitator running — then add the water-soluble pouches to the tank.
- Most pouches dissolve completely within 5 minutes, depending on the water temperature and the degree of agitation.
- As the tank continues to fill, add any other compatible pesticides.

Do not add:

- A pesticide that is incompatible with the PVA packaging material. The PVA material is not soluble with oils (e.g., Superior Oil).
- Any material containing boron (e.g. Solubor), chelated micronutrients or water-soluble fertilizers. This combination is likely to cause a sticky, insoluble substance in the tank.

If you apply boron, chelated micronutrients or water-soluble fertilizers, make sure you completely empty and rinse the spray tank before using any product packaged in PVA.

Compatibility of spray materials

For information on compatibility of spray materials, **always check the product label.** Compatibility refers to the physical or chemical compatibility of 2 products in solution.

Physical incompatibility: combinations result in a physical change in the solution. Components of the combined product may plug nozzles, become solidified or gummy in the tank.

Chemical incompatibility: can result in chemical changes in the spray solution that can lead to reduced efficacy, or can cause plant injury when sprayed on the crop. The results of a chemical incompatibility may not be evident until after the spray is applied.

In general:

- Compatibility of 2 products may vary with the formulation of those products. For example, 2 products may be compatible as wettable powder (WP) formulations, but the same active ingredient may not be compatible as (EC) formulations.
- Compatibility generally refers to 2-way mixtures. Adding a 3rd product to a tank-mix, even if all are compatible with each other in 2-way combinations, may result in further incompatibility.
- Compatibility of some materials may depend on the solvents and emulsifiers used by the manufacturer. Emulsifiable concentrates are more likely to cause compatibility problems than wettable powders. If wettable powders are mixed with emulsifiable concentrates, incompatibilities may result.

Specifically:

- When mixing Captan or Maestro with EC formulations of pyrethroids, add Captan or Maestro first. Apply immediately with constant agitation.
- Do not mix pesticides with lime sulphur or with streptomycin.
- Do not use oil sprays within 14 days of Captan or Maestro. This applies also to the oil used with Agri-Mek.
- Water soluble, polyvinyl alcohol packaging (PVA) material is not compatible with Superior Oil, or EC formulations containing mineral or vegetable oil products.

Water-soluble packaging is not compatible with boron, some chelated micronutrients and water-soluble fertilizers. Rinse the spray tank carefully after applying these nutrients, before using products in water-soluble packages.

For more information on compatibility, contact the product manufacturer or dealer. See Table 12-1, *Pesticides used on fruit crops in Ontario*, on page 217 to find the manufacturer's or agent's code for the products you want to mix. Use Table 12-5, *Pest control product companies*, on page 227 to find contacts for more information.

Spraying speeds

Uniform application rates require a constant forward speed whenever spray nozzles deliver liquid. If a tractor's driving wheels slip on the soil surface, the tractor's speedometer will not indicate a change in forward speed.

- To monitor forward speed despite wheel slippage on hills, use an independent speedometer with a ground-driven wheel.
- Install spray monitors and other electronic rate controllers. These automatically correct for variations in tractor speed to maintain a constant application rate.

Cleaning the Sprayer

- Clean sprayers immediately after spraying each day and whenever you change chemicals. Delaying even overnight allows persistent deposits to form.
- Do not neglect any sprayer parts. Clean the spray tank, booms, hoses, nozzles, tips, screens, filters, strainers and pumps. Be sure to remove every trace of pesticide.
- Cleaning techniques depend on the pesticide. Many pesticides list tank-cleaning information on the label — always follow these instructions. If necessary contact the pesticide manufacturer to learn the best cleaning methods for a product. If you cannot get specific cleaning instructions, use a strong detergent or alkaline cleaner. Then rinse thoroughly.
- Surfactants may remove pesticide residues from spray equipment. Before using herbicide or surfactant mixtures (e.g. Agral 90), be sure the tank is scrupulously clean. Otherwise the mixture may remove residues from the sprayer, adversely affecting the crop.

Environmental issues when cleaning

- Before cleaning the sprayer, you must safely dispose of any surplus tank-mix. Refer to *Surplus spray mix* on page 13.
- Equipment used with 2,4-D, MCPA or related phenoxy herbicides must never be used to spray other types of solutions on 2,4-D-susceptible crops or garden plants. Never store these products near greenhouses or other areas with susceptible crops.

- The wash water contains pesticides. Never allow wash water into a well, lake, pond, river or other water source.

Sprayer Calibration

Most problems with pesticide application can be prevented if sprayers are properly calibrated. Poorly calibrated sprayers can be the cause of several problems.

- **Pest escapes**: Uneven application or improper dosage can result in poor pest control.
- **Pesticide residues**: Inconsistent application rates may leave excessive residue levels on fruit.
- **Crop damage**: Uneven nozzle outputs will deposit too much product on sensitive crops.
- **Poor returns**: Expensive re-application of pesticides together with losses in yield and quality can lower expected returns on high value crops.

Boom sprayer calibration

Field boom type sprayer calibration
(Determining application rates in L/ha)

There are many ways of determining the number of litres of spray material that are being applied to 1 ha of land — or calibrating a sprayer.

1. Measure the time.
   - Place 2 stakes, 50 m apart in the field.
   - Select the gear and throttle setting (rpm) at which you plan to spray.
   - Fill the sprayer half full of water.
   - Drive the distance between the stakes 3 times, timing each pass. Each time, make sure the tractor is at the desired speed as you pass the first stake. Keep driving at this speed until you pass the second stake.
   - Take the average time of the 3 passes.
2. Measure the average nozzle output.
   - Park the sprayer with the PTO engaged and the throttle adjusted to reach the PTO speed set in the test run.
   - Adjust the pressure regulator to the desired working pressure with full flow to the boom.
   - Collect the output from each nozzle for the average length of time needed to travel the 50 m in the test run.
   - Enter the nozzle outputs into the equation below.
   - If any nozzle is more than 5% above or below the average output, it should be cleaned or replaced.
3. Measure the nozzle spacing in metres.
4. Use the following formula to determine the sprayer output:

$$\begin{array}{c}\text{Sprayer Output}\\ \text{(litres/hectare)}\end{array} = \frac{\text{Average Nozzle Output (mL)}}{\text{Nozzle Spacing (meters)}} \times 0.2$$

5. Calculate the actual area sprayed after each tank of spray solution is applied. Recheck the actual sprayer calibration after each tank of spray is applied by dividing the volume sprayed by the actual area sprayed. The nature of some products may slightly alter the calibration from that of clean water.
6. Growers who prefer to measure in litres per acre or gallons per acre can use the conversion factors, on page 21.

Band spraying

For banded spray applications, measure the width of the spray band (at the soil surface or surface of the crop canopy) and enter this value into the formula instead of the "nozzle spacing".

For example, if the sprayer has 10 nozzles and each nozzle covers a 36 cm (0.36 m) band, the total width of the spray patterns (swath width) is: 10 × 0.36, or 3.6 m.

Where band spraying, the acreage sprayed is not the same as the crop acreage. Unless otherwise stated, the herbicide rates referred to in most herbicide publications and labels refer to the actual area sprayed.

Notes:

- Sprayer calibration bottles or kits are available from a number of suppliers. For further information contact the manufacturers of sprayers, sprayer parts or herbicides.
- See also the calibration calculator on the OMAF web site *www.gov.on.ca*.

Conversion factors:
L/ha x 0.4 = L/acre
L/ha x 0.11 = U.S. gal/acre
L/ha x 0.09 = Imp. gal/acre

Sample calculation:
Time to travel 50 meters (164 feet): 24.5 seconds
Liquid collected/nozzle for 24.5 seconds: 525 mL
Nozzle spacing on the boom: 0.5 m

Application rate: $$\frac{525\ \text{mL} \times 0.2}{0.5\ \text{m}} = 210\ \text{L/ha}$$

Conversions:
210 L/ha x 0.4 = 84 L/acre
210 L/ha x 0.11 = 23 U.S. gal/acre
210 L/ha x 0.09 = 18.9 Imp. gal/acre

Guide for Spraying Fruit Trees

General considerations

- The sprayer must be large enough to cover the orchard in the time available and under adverse conditions.
- Equipment must be in top condition.
- Trees must be pruned so the spray penetrates easily.
- Weather conditions must be monitored and the orchard scouted routinely for disease, insect pest numbers and stages so that spray timing is accurate.

Calculating water volume and pesticide rates

Water volumes

Categories of spray volumes for air-blast sprayers are listed in Table 2–1, *Categories of spray volumes for air-blast sprayers*. Using ultra-low volume sprays is not recommended, unless specified for use on the label. Most fruit tree pests and diseases can be controlled with low-volume air blast sprays. Relatively stationary pests, such as mites and pear psylla nymphs, are best controlled with medium spray volumes. High volume air-blast spraying causes dripping and spray runoff. This is needed to control some pests, such as European red mite eggs or San Jose scale insects.

High volume air-blast spraying is sometimes referred to as dilute spraying. Dilute sprays are applied in enough water volume to wet all foliage to the point of runoff. Although growers rarely use dilute sprays, you should know the amount of water required to spray each block of orchard dilute. For mature trees 4.5–5.5 m high, this is approximately 3,000 L water/ha.

TABLE 2–1. Categories of spray volumes for air-blast sprayers

Category	Spray volume
Ultra low volume	5–6 L/ha or less
Low volume	Usually 550–850 L/ha, but may be as low as 100 L/ha for some sprayers. No runoff occurs.
Medium volume	1,000–2,250 L/ha. Spray droplets flow together on the sprayed surfaces. Little or no runoff occurs.
High volume	2,250–5,500 L/ha. Runoff occurs.

- Choose a water volume that provides even spray coverage using your application equipment for your tree size. Consider the target pest.
- Using lower water volumes to apply pesticide takes less time and less water. However, excessively low-volume applications often result in poor control of scale insects, mites and woolly aphid, especially in tree tops.
- Many growers adjust the water volume and rate of pesticide applied in different blocks by turning off certain nozzles, or by adjusting driving speed. This allows growers to spray different orchard blocks, of different tree sizes, while maintaining the same amount of chemical in each full tank of water.

Pesticide rates

Fruit trees change in size considerably from the time they are planted to when they reach maturity. Rootstocks and variety also affect the size of a tree and the volume of the tree canopy.

Traditionally, rates on pesticide labels are based on mature trees. An assumption has been made that mature trees are 4.5–5.5 m high, and require a water volume of 3,000 L/ha for dilute spraying. Growers can adjust rates for canopy volumes that require more, or less, than 3,000 L/ha of water for a dilute application.

For newer pesticides, rates have been developed in orchards with dwarf and semidwarf trees where water rates have been adjusted to tree row volume. In these cases, reduced rates may result in failure of the product to control the target pest. Always consult the label for the rate and water volumes needed.

Companies are not liable for pest control failures due to use of rates below those recommended on their labels.

Table 2–2, *Water volume guidelines based on tree row volume* recognizes that effective coverage of smaller tree canopies can be achieved when using a lower volume of spray solution. The method of calculating spray volume requirements for tree canopies is called tree row volume. For further explanation and instruction, refer to OMAF Factsheet, *Guide for Spraying Fruit Trees,* Order No. 00-035 or Publication 310, *Integrated Pest Management for Ontario Apple Orchards.*

TABLE 2–2. Water volume guidelines based on tree row volume

Tree height	Pesticide/ha	Water/ha for dilute spraying
6 m & over	1 $^{1}/_{3}$ x recommended rate	4,000 L
4.5–5.5 m	full recommended rate	3,000 L
2.5–3 m	$^{2}/_{3}$ recommended rate	2,000 L

Air-blast sprayer set up

Proceed through the following 7 steps.

1. Check tractor speed. (See Table 2–4, *Time required to pass a number of trees at different driving speeds,* on page 23.)
2. From Table 2–3, *Spraying time per hectare (without turning and filling time)*find the number of minutes needed to spray a hectare at the speed recommended for your sprayer.
3. Decide how many litres of liquid per hectare you will use (considering time available, size of sprayer, size of trees and time of spraying). Using tree row volume can help determine the spray volume required.
4. Find the sprayer output required:

   litres/hectare ÷ time/hectare = litres/minute (for all nozzles)
5. Divide the output by the number of nozzles:

   litres/minute ÷ number of nozzles = litres/minute (per nozzle)
6. From manufacturer's nozzle charts, find a nozzle to give this output at the selected operating pressure. Then choose nozzles with smaller outputs for top and bottom positions and larger ones for the upper third of each side. When added, the total output should be close to the value shown in step 4 (above) (L/min). For small trees, block off 1 or 2 of the top nozzles and shut off between trees to prevent waste of spray.
7. After selecting the nozzles, calibrate the sprayer. Fill the tank with water and spray for 3 minutes. Use a flow-metering device or a pail calibrated in litres to refill the tank to its original level. The amount required to refill the tank should equal the litres per minute calculated in step 4, multiplied by 3 minutes.

Pesticide Injury to Crops

Although insecticides and fungicides have been selected and formulated to avoid plant injury, damage can, under some conditions, still occur. Observe the following precautions.

- Apply sprays when the drying condition is fast. Some chemicals break down to components that are injurious to plant tissues if permitted to stay wet.
- Apply sprays when temperature is below 27°C. The spray deposits serve as a lens and concentrate the heat on the plant tissues.
- Be particularly careful when plants have been under growth stress such as prolonged periods of drought, excessive cloud cover, extremely low or high temperatures.
- Apply sprays soon after mixing. Undesired chemical change may take place with some chemicals if the sprays remain in the tank for prolonged lengths of time (e.g. overnight). In other cases, the chemicals may settle out and clog the lines.

TABLE 2-3. Spraying time per hectare (without turning and filling time)

		Tractor speeds (km/hr)						
		1.6	**2.4**	**3.2**	**4.0**	**4.8**	**5.6**	**6.4**
		Time (in minutes) to drive 1 ha						
Distance between rows (metres)	3.1	125	82.5	62.5	50	41.25	35	31
	4.6	82.5	55	41.25	33	27.5	23.5	20.5
	6.1	62.5	41.25	31	25	20.5	17.75	15.5
	7.6	50	33	25	20	16.5	14	12.5
	9.1	41.25	27.5	20.5	16.5	13.75	11.75	10.25
	10.7	35.25	23.5	17.75	14	11.75	10	8.75
	12.2	31	20.5	15.5	12.5	10.25	9.5	7.75

TABLE 2-4. Time required to pass a number of trees at different driving speeds

		In the row tree spacings (meters)							
		1.6	**3.1**	**4.6**	**6.1**	**7.6**	**9.1**	**10.7**	**12.2**
		Time (seconds) to pass 10 trees							
Tractor speed (km/hr)	2.4	23	45	68	91	114	136	159	182
	3.2	18	34	51	68	85	102	119	136
	4.0	14	27	40	54	68	82	95	109
	4.8	12	23	34	45	58	70	82	94
	5.6	10	19	27	39	49	58	68	78
	6.4	9	17	26	34	43	51	60	68

3. Soil Management, Cover Crops and Fertilizer Use

For a complete guide to soil fertility, consult OMAF Publication 611, *Soil Fertility Handbook*.

Soil Testing

Ontario currently uses almost 740,000 tonnes of fertilizer annually. High yields can only be produced efficiently when fertilizer use is related to:

- fertility level of the soil
- additions of nutrients from manure
- crop residues
- other organic sources.

At one extreme, on very low fertility soils, it can be profitable to add as much or more nitrogen, phosphorus or potassium to the soil as a crop removes. But on high fertility soils, or following heavy application of manures, fertilizer may not be profitable, and occasionally may reduce yields.

Why Soil Test?

Soil tests accredited by OMAF are an accurate tool for Ontario farmers to determine the amount of phosphorus, potassium and magnesium fertilizers, and lime to apply for crop production. If you are required to complete a nutrient management plan under the *Nutrient Management Act*, Ontario Regulation 267/03 (new or large livestock farms) you must use OMAF-accredited tests for the plan.

Always take a soil test well in advance of establishing perennial fruit crops in order to correct any nutrient deficiencies or pH problems. Always ask for OMAF-accredited soil tests.

See *Appendix B, Accredited Soil Testing Laboratories in Ontario*, page 232 for a list of labs that provide OMAF-accredited soil tests.

Other methods of assessing nutrient needs

Plant analysis is routinely used for tree fruits and several berry crops. Plant analysis can provide additional information supporting the soil test for field and vegetable crops.

In some cases, **nutrient deficiency symptoms** on crop leaves help identify deficiencies. However, this method is not always appropriate for determining potassium and phosphorus levels because yield losses can be significant before deficiency symptoms appear.

It is possible to apply the amount of nutrients removed by a specific crop. This works with nitrogen, since there are some crops where the suggested rate approximates what the plant removes. But it does not apply for other nutrients in Ontario. Some clay and clay loam soils have sufficient potassium to last many years. Applying potassium each year on those soils is not cost effective.

Benefits of the OMAF-accredited soil testing program

Use the OMAF-accredited soil testing program, along with plant analysis and observing nutrient deficiency symptoms, to determine fertilizer requirements for a specific crop on a specific field. Be certain that the service you use is accredited. To be accredited, a laboratory must use OMAF-approved testing procedures, demonstrate acceptable analytical precision and accuracy, and provide the OMAF fertilizer recommendations.

The OMAF-accredited soil testing program provides recommendations for nitrogen, phosphate, potash and magnesium rates, as well as the amount and type of lime required. (See Table 3–1, *OMAF-accredited soil tests*, page 26.) The OMAF-recommended fertilizer rates are provided in the crop-specific chapters in this publication. These recommendations are designed to produce the highest economic yields when accompanied by good or above average management.

A number of laboratories provide soil tests for cation exchange capacity, aluminum and copper. These tests are not accredited by OMAF because they have not been found to contribute to better fertilizer recommendations. Research has shown that using cation exchange capacity to adjust potash recommendations on Ontario soils can lead to less reliable recommendations than are now provided.

Refer to Appendix B, *Accredited Soil Testing Laboratories in Ontario*, on page 232 for a list of laboratories that provide OMAF-accredited soil tests.

TABLE 3–1. **OMAF-accredited soil tests***

Materials analyzed	What is analyzed[1]
Soils for crops, commercial turf, etc.	Plant-available phosphorus, potassium, magnesium, manganese and zinc; pH; lime requirement
Greenhouse media	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts
Nutrient solutions, water	Plant-available nitrogen, phosphorus, potassium, calcium, magnesium; pH; total salts; sulphates; chlorides

* See Appendix B, *Accredited Soil Testing Laboratories in Ontario*, on page 232 for a list of laboratories that provide OMAF-accredited soil tests.

[1] Soil organic matter can be useful for herbicide recommendations, but it is not an accredited test.

Soil sampling

- Sample soils with a soil probe. Sample each field, or uniform section of a field, separately. Take at least 20 soil cores, 15 cm deep, from any field or area sampled up to 5 ha in size. For fields larger than 5 ha take proportionately more cores. The more cores taken the more likely the soil sample will provide a reliable measure of the fertility in the field. One sample should not represent more than 10 ha.
- Collect soil in a clean plastic pail. Break up lumps, mix the soil well and place in a soil sample box. Traverse the area in a zigzag pattern to provide a uniform distribution of sampling sites. Sample separately parts of a field that differ in appearance of soil or crop, or parts of the field that were limed, fertilized or treated with manure differently than the rest of the field. Sample these areas separately even if they are too small to fertilize separately. Avoid sampling recent fertilizer bands, dead furrows, areas adjacent to gravel roads or where lime, manure, compost or crop residues have been piled.
- Sample each field prior to establishing a crop and once every 2 or 3 years after that. If your farm requires a nutrient management plan (NMP), you must collect soil samples at least once from each field for every NMP renewal.

Analysis takes time. Ideally, take soil samples the previous fall from fields to be fertilized for spring planting. You can also take soil samples in summer.

Management practices that affect a soil test recommendation include:

- manure application
- legume sod plowed down
- the crop to be fertilized.

This information is essential for a reliable fertilizer recommendation. Remember to record it on the field information sheet that accompanies the soil sample sent for analysis.

Testing soil for micronutrients

OMAF-accredited soil tests are available for manganese and zinc. Plant analysis and observation of visible symptoms are also useful for monitoring these nutrients. OMAF-accredited soil tests are not available for boron, copper, iron or molybdenum. Plant analysis is generally a better indicator of deficiencies of these nutrients.

Micronutrient deficiencies or pH problems frequently occur in small patches in fields. In these cases, soil or plant samples taken from the entire field are unlikely to indicate the problem. Sample problem areas separately.

Take care to prevent contamination of soil samples with micronutrients, particularly zinc.

- Do not use galvanized (zinc plated) soil sampling tubes to take soil samples for micronutrient tests. Soil samples that have contacted galvanized surfaces are unsatisfactory for zinc soil tests.
- Use clean plastic containers in good condition. Do not use metal containers to collect and mix samples.
- Be careful to keep dust around buildings, etc., out of the samples.

Plant Analysis

Plant analysis measures the nutrient content of plant tissue (i.e., leaves, petioles or fruit). Plant analysis is a well-established procedure and standards exist for accurate interpretation. Comparing the results against the ***normal*** and ***critical*** values for the crop can indicate whether the nutrient supply is adequate for optimum growth. Plant analysis is presently recommended for:

Apples	page 26
Blueberries	page 116
Grapes	page 154
Peaches	page 172
Pears	page 172
Plums	page 172
Raspberries	page 118
Sour cherries	page 172
Strawberries	page 120

Plant analysis is more important than soil test results for fertilizer recommendations for tree fruits and grapes. Refer to OMAF Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

Plant analysis is also a useful supplement to soil testing for evaluating the fertility status of crops other than perennial fruit crops. It is independent of soil testing and can provide a valuable second opinion, especially for phosphorus, potassium, magnesium and manganese. It has not been very reliable for nitrogen and zinc. There is no reliable soil test for boron and copper, so use plant analysis and visual symptoms to diagnose deficiencies.

Plant analysis has limitations. Expert help in interpreting the results is often needed since plant analysis does not usually indicate the cause of a deficiency or the amount of fertilizer required to correct it.

Sampling

Time of sampling can affect plant analysis results. Nutrient levels in plant tissue vary considerably from early season through fruit set and ripening. Results are difficult to interpret if samples are taken at times other than those recommended. Nevertheless, take samples as soon as a problem appears. Take samples from the problem area, plus an adjacent healthy area for comparison.

- Take samples from at least 20 plants of the same variety distributed throughout the sampling area. Each sample should consist of at least 100 grams of fresh material.
- Sample problem areas separately.
- Do not contaminate the sample with soil. Even a small amount of soil invalidates the results, especially for micronutrients.

Sample preparation

Deliver samples of fresh plant material directly to the laboratory. If not delivered immediately dry your samples to prevent spoilage. Dry the samples in an oven at 65°C or less, or in the sun, taking precautions to prevent contamination with dust or soil. Avoid contact of samples with galvanized (zinc coated) metal, brass or copper.

Plant analyses may be obtained from several accredited laboratories in Ontario. (See Appendix B, page 232.)

Fertilizer Recommendations

See also:

Apple Nutrition	page 68
Berry Crop Nutrition	page 115
Grape Nutrition	page 154
Tender Fruit Nutrition	page 171

Nitrogen

Nitrogen fertilizer recommendations for fruit crops are based on estimated crop requirements and on plant analysis. Recommended rates are presented in the fertilizer section for each crop. Rates are adjusted downward if manure is applied or if the previous crop contained perennial legumes, such as alfalfa.

Make sure the combined application of fertilizer, manure, biosolids and other sources of nitrogen does not supply nitrogen in excess of the crop's requirement. This will protect crop quality and help prevent surface and groundwater pollution.

Phosphate and Potash

Phosphate and potash recommendations are based on OMAF soil tests. Recommended amounts are provided in the chapter specific for each crop. Use these recommendations only with OMAF-accredited soil tests. Non-accredited tests may use extractants that pull out different amounts of nutrient, so they will not give correct answers if used with the OMAF tables.

Phosphorus (P)

Soil test results for phosphorous include a rating (low, medium, high, excessive) that reflects the likelihood of a crop response to applied phosphorus. Soils that test excessive for phosphorus contain more plant-available phosphorus than is required by most crops. Applying additional phosphorus — whether from fertilizer, compost, manure or sewage biosolids — is unlikely to provide a yield increase, and may interfere with availability and uptake of other nutrients.

The risk of surface water contamination by phosphorus is affected by:

- soil test phosphorus levels
- the movement of soil, and phosphorous bound to soil particles, from a field by erosion.

Because of this, the risk of surface water contamination by phosphorus cannot be based on a soil-test phosphorus level alone. Wherever soil tests are very high or excessive, use a phosphorus index to guide the applications of any source of phosphorus. A phosphorus index can rank the relative risk of surface water contamination for applications made to a particular area of land. It also determines maximum application rates if manure is applied, and required setbacks from watercourses. For more information, see the OMAF Factsheet *Determining the Phosphorous Index for a Field*, Order No. 03-109.

Potassium (K)

Some clay and clay loam soils are naturally high in potassium and do not require any potash fertilizers. Only a soil test can adequately determine potash requirements.

Changes in crop or management that affect fertilizer recommendations

Fertilizer recommendations on the OMAF soil test report are for specific crops using specific management practices.

- Use Table 3–5, *Average amounts of available nutrients for different types of manure*, on page 31 to adjust fertilizer recommendations following a change in manure application.
- Use Table 3–6, *Adjustment of nitrogen requirements where crops containing legumes are plowed down*, on page 32 to make adjustments for legumes plowed down.
- If the crop is changed, get a new recommendation by finding the appropriate table for that specific crop.

Nutrient Management Plans

A nutrient management plan matches the nutrients available from manure, cover crops or legumes plowed down, commercial fertilizer, other nutrient sources and the soil to the nutrients required by the crop. Analysis of nutrients contained in the manure and other nutrient sources, along with soil test results and crop requirements, help to determine application rates and additional fertilizer requirements.

Follow a nutrient management plan to:

- optimize the nutrients applied for crop yield and profitability
- reduce the risk of surface or groundwater contamination by nitrogen or phosphorus.

Regulations under the *Nutrient Management Act* require some farmers to complete nutrient management plans (NMPs) for their farming operations. This requirement applies to new livestock operations and to operations expanding above 300 nutrient units. The above regulations will apply to existing operations that generate 300 nutrient units or more on July 1, 2005.

Other farms that receive and apply nutrients may come under a requirement to complete a NMP at a future date. Outside of legal obligation, many farmers are completing nutrient management plans on their own because it saves them money and improves the management of nutrient sources on their farms.

Soil Acidity and Liming

The pH scale ranging from 0 to 14 is used to indicate acidity and alkalinity. A pH value of 7.0 is neutral; values below 7.0 are acid and those above 7.0 are alkaline. Most crops grow well in a soil pH range from 6.0–8.0.

To correct soil acidity, broadcast ground limestone and work it into the soil at rates determined by a soil test. Refer to Table 3–2, *Soil pH at which lime is recommended for Ontario crops*, on page 29 for the pH values below which lime is recommended and the target soil pH to which soils should be limed. In Ontario most crops grow quite well at pH values higher than the target pH to which lime is recommended.

The buffer pH

Different soils with a similar soil pH value require different amounts of lime to bring the pH to a particular desired level. The amount of lime required depends on the clay and organic matter content of each soil. The

TABLE 3–2. Soil pH at which lime is recommended for Ontario crops

Crops	Soil pH below which lime is recommended	Target soil pH*
Coarse and medium-textured mineral soils (sand, sandy loams, loams and silt loams)		
Perennial legumes, oats, barley, wheat, beans, peas, canola, flax, tomatoes, raspberries, strawberries, new plantings of tree fruits or grapes, all other crops not listed below (except blueberries)	6.1	6.5
Corn, soybeans, rye, grass, hay, pasture, tobacco	5.6	6.0
Potatoes	5.1	5.5
Fine-textured mineral soils (clays and clay loams)		
Alfalfa, cole crops, rutabagas	6.1	6.5
Other perennial legumes, oats, barley, wheat, soybeans, beans, peas, canola, flax, tomatoes, strawberries, raspberries, new plantings of tree fruits or grapes, all other crops not listed above or below (except blueberries)	5.6	6.0
Corn, rye, grass, hay, pasture	5.1	5.5
Organic Soils (peats and mucks)		
All field and vegetable crops	5.1	5.5

* Where a crop is grown in rotation with other crops requiring a higher pH (e.g. corn in rotation with wheat or alfalfa), lime the soil to the higher pH.

soil pH determines which soils need to be limed. However a separate soil test, the buffer pH, is run on soils needing lime to determine the amount of lime required. For soils needing lime use Table 3–3, *Lime requirements to correct soil acidity based on soil pH and soil buffer pH*, on page 30 to determine the amount of lime required to reach different target soil pH values required for different crops.

The soil pH determines which soils need lime. The buffer pH indicates how much lime is required.

Limestone quality

Calcitic limestone consists largely of calcium carbonate. **Dolomitic limestone** is a mixture of both calcium and magnesium carbonates.

- *On soils with a magnesium soil test of 100 ppm or less:* Use dolomitic limestone. It is an excellent and inexpensive source of magnesium for acid soils.
- *On soils with magnesium tests greater than 100 ppm:* Use calcitic or dolomitic limestone.

Two factors affect the value of limestone for soil applications:

- neutralizing value and
- particle size.

Neutralizing value is the amount of acid a given quantity of limestone will neutralize when it is totally dissolved. It is expressed as a percentage of the neutralizing value of pure calcium carbonate. Limestone that neutralizes 90% as much acid as pure calcium carbonate has a neutralizing value of 90. In general, the higher the calcium and magnesium content of a limestone, the higher the neutralizing value.

The second factor affecting limestone quality is **particle size**. Limestone rock has much less surface area to react with acid soil than finely powdered limestone; therefore it neutralizes acidity much more slowly — so slowly it is of little value. The fineness rating for limestone reflects the particle size.

The calculation of a fineness rating for ground limestone is illustrated in Table 3–4, *Example calculation of the fineness rating of limestone*, on page 30.

The agricultural index

Some means of combining the neutralizing value and the fineness rating is needed to compare various limestones available. The index developed in Ontario to do this is the **agricultural index.**

The agricultural index compares the relative value of different limestones for neutralizing soil acidity. Lime with a high agricultural index is worth proportionately more than lime with a low index because it may be applied at a lower rate.

For example, suppose 2 ground limestones, A and B, have agricultural indices of 50 and 80 respectively. The rate of application of limestone A required for a particular soil will be 80/50 multiplied by the rate required for limestone B. Limestone A spread on your farm is worth 50/80 multiplied by the price of limestone B per tonne.

TABLE 3–3. Lime requirements to correct soil acidity based on soil pH and soil buffer pH

Buffer pH	Target soil pH = 6.5[1]	Target soil pH = 6.0[2]	Target soil pH = 5.5[3]
Ground limestone required t/ha (based on an Agricultural Index of 75)			
7.0	2	1	1
6.9	2	1	1
6.8	2	1	1
6.7	2	2	1
6.6	3	2	1
6.5	3	2	1
6.4	4	3	2
6.3	5	3	2
6.2	6	4	2
6.1	7	5	2
6.0	9	6	3
5.9	10	7	4
5.8	12	8	4
5.7	13	8	5
5.6	15	11	6
5.5	17	12	8
5.4	19	14	9
5.3	20	15	10
5.2	20	17	11
5.1	20	19	13
5.0	20	20	15
4.9	20	20	16
4.8	20	20	18
4.7	20	20	20
4.6	20	20	20

[1] Lime if soil pH below 6.1
[2] Lime if soil pH below 5.6
[3] Lime if soil pH below 5.1

TABLE 3–4. Example calculation of the fineness rating of limestone

Particle size	% of sample	Effectiveness factor
Coarser than #10 sieve[1]	10	× 0 = 0
#10 to #60 sieve	40	× 0.4 = 16
Passing through #60 sieve	50	× 1.0 = 50
Fineness rating		= 66

[1] A #10 Tyler sieve has wires spaced 2.0 mm, and a #60 Tyler sieve has wires spaced 0.25 mm apart.

Recommendations from the OMAF-accredited soil tests are based on limestone with an agricultural index of 75. If you purchase lime with an agricultural index other than 75, you can calculate a rate of application specifically for that limestone. You must know the agricultural index of the lime you purchase. Use the following equation:

$$\text{Application rate} = \frac{75}{\text{agricultural index}} \times \text{(application rate from soil test)}$$

For example, if you have a limestone requirement by soil test of 9 t/ha, and your most suitable source of limestone from a quality and price standpoint has an agricultural index of 90, apply 75/90 × 9 = 7.5 t/ha.

Tillage depth

Lime recommendations presented here should raise the pH of the top 15 cm of a soil to the listed target pH. If the soil is plowed to a lesser or greater depth than 15 cm, proportionately more or less lime is required to reach the same target pH. Where reduced tillage depths are used, reduce the rates of application proportionately. More frequent liming will be needed.

Lowering soil pH

On soils with pH values below 6.5 you can lower the pH (make the soil more acid) by adding sulphur or ammonium sulphate. This is not advisable for most crops, but may be beneficial for blueberries. If the soil pH is above 6.5, it is not advisable and also usually quite impractical to lower the soil pH because of the very large amounts of sulphur or ammonium sulphate required. Refer to *Blueberries, pH requirements*, page 115 for more detail.

Managing Organic Nutrient Additions

Manure is an important organic amendment that contains considerable amounts of nitrogen and potassium, smaller amounts of available phosphorous, and a number of micronutrients. When using manure, reduce fertilizer rates as indicated either in Table 3–5, *Average amounts of available nutrients for different types of manure*, on page 31 or based on an analysis of the manure nutrient content. Do not ignore the nutrients added in manure or other organic sources. Excess nutrient application can reduce crop quality and winter hardiness as well as increase environmental risk.

TABLE 3-5. Average amounts of available nutrients for different types of manure[1]

Use this data for information only, but refer to the *Nutrient Management Computer Program* or Publication 818, *Nutrient Management Workbook* for more specific values. These values are continually updated as new data from manure analyses is entered into the database. Nutrient Management Plans that are not based on analytical results must be based on the NMAN values.

Manure	Average dry matter	Available nitrogen[2] spring 1 day	Available nitrogen[3] spring not incorp.	Available P_2O_5 [4]	Available K_2O [5]
			kg/1,000 L (lb./1,000 gal)		
Liquid dairy	6.5%	1.6 (16)	0.6 (6)	0.7 (7)	3 (30)
Liquid hog	3.6%	2.6 (26)	0.7 (7)	1.1 (11)	2 (20)
Liquid poultry	8.0%	6.1 (61)	1.7 (17)	2.5 (25)	3.4 (34)
Liquid biosolids (sludge)[6]	4.4%	1.2 (12)	0.6 (6)	1.3 (13)	0.2 (2)
			kg/tonne (lb./ton)		
Solid biosolids	36%	1.5 (3)	0.75 (1.5)	11 (22)	0 (0)
Solid poultry	49%	11.5 (21)	6 (12)	9 (18)	12.5 (25)
Solid dairy	20%	1.5 (3)	0.7 (1.4)	1.5 (3)	4.8 (9.7)
Solid beef	28%	1.5 (3)	0.75 (1.5)	2.1 (4.2)	6.1 (12.3)

[1] Nutrient values based on average analysis results for more than 700 samples. There are large variations between different manures, so a manure analysis is your best guide to nutrient availability.

[2] Nitrogen based on spring application, incorporated within 24 hours.

[3] Nitrogen based on spring application, not incorporated (i.e. on soil surface for more than 7 days).

[4] Phosphate from manure or biosolids is assumed to be 40% as available as that in manufactured fertilizer in the year of application.

[5] Potash from manure or biosolids is assumed to be 90% as available as that in manufactured fertilizer in the year of application.

[6] For biosolids (e.g. sewage sludge), you must get a certificate of approval from MOE. This can take up to 6 months.

Biosolids derived from paper mill fibre have been used in orchards and vineyards to maintain soil organic matter. Before this material can be applied to land, you must have a Certificate of Approval issued by the Ontario Ministry of the Environment (MOE) for the site. Rates can be in the range of 25–30 dry t/ha but will vary according to the nitrogen content of the material. The MOE has final approval of the material and the applied rate. Any application restrictions are included as conditions on the Certificate of Approval.

Sewage biosolids are a source of nitrogen, phosphorous and organic matter. As with paper mill fibre, a Certificate of Approval is required for the site receiving sewage sludge. Before sewage sludge can be applied to land it must qualify under the MOE guidelines. These guidelines place restrictions on the types of crops receiving sewage sludge and the waiting periods between application and harvest. For tree fruits and grapes the waiting period is 3 months. The required waiting period between sewage sludge application and small fruit (strawberries, raspberries and blueberries) harvest is 15 months.

Some processing companies that contract crops may have concerns about sludge applications to fields where certain crops are grown. Contact companies prior to spreading sewage sludge to confirm they will accept your crop.

Straw and spoiled hay are other excellent sources of organic matter. Where manure is too costly or difficult to obtain, straw or hay can be used. Seven tonnes per hectare of straw or old hay will supply approximately the same amount of dry matter as 22 t/ha of cattle manure. One disadvantage to using these materials is that weed seeds can be transported in the hay or straw.

Fertilizer adjustments for legumes plowed down

When perennial legumes such as alfalfa, trefoil and clover are plowed under, they supply an appreciable amount of nitrogen to the following crop. Unfortunately, the rate of release is variable, and depends on soil and weather conditions. Late release of nitrogen may predispose fruit crops to winter injury. If perennial legumes are grown prior to planting fruit crops, use Table 3-6, *Adjustment of nitrogen requirements where crops containing legumes are plowed down*, on page 32 to adjust nitrogen fertilizer applications.

Fertilizer adjustments following use of manure

Careful management of nutrients from manure is essential for optimum economic benefit to the farmer with minimal impact on the environment.

TABLE 3–6. Adjustment of nitrogen requirements where crops containing legumes are plowed down

Type of crop	For all crops deduct from N requirement (kg N/ha)
Less than 1/3 legume	0
1/3 to 1/2 legume	55
1/2 or more legume	100
Perennial legumes seeded and plowed in same year	45[1]
Soybean and field bean residue	0

[1] Applies where the legume stand is thick and more than 40 cm high.

The value of manure in crop production is often underestimated. Manure contains all nutrients needed by crops but not necessarily in the proportions needed. In addition to nitrogen, phosphorus and potash, manure contains many secondary and micronutrients, and organic matter that helps build and maintain soil structure.

Manure analysis

Manure analysis is necessary because the quantities of nutrients contained in manure, especially phosphorus and potash, vary between farms. The following factors affect nutrient content of manure:

- type of livestock
- ration
- bedding
- added liquids
- manure storage system.

Manure analysis is available from several soil-testing laboratories in Ontario. (See Appendix B, *Accredited Soil Testing Laboratories in Ontario* on page 232.) Perform a manure analysis after complete agitation or thorough mixing and each time the storage is emptied (e.g. spring and fall). After several analyses, a trend develops and you can limit sampling to major changes in ration or other management factors as long as the manure source remains the same.

When sending a sample to the lab, fill a plastic jar (about 2 L capacity) half full, cover and place in a plastic bag. Store the sample in a cool place until shipping.

Analysis should include total nitrogen, ammonium-nitrogen (NH_4-N), phosphorus, potassium and dry matter. Ontario labs send back analysis results with percentages for nitrogen, phosphorus, potassium and dry matter as well as mg/kg (or ppm) of ammonium-nitrogen. Percentages for phosphorus and potassium from manure are converted to commercial P_2O_5 and K_2O equivalents and commercial fertilizer reductions are given.

For more information on manure analysis, the available nitrogen in manure, and calibrating manure spreaders, see OMAF Publication 611, *Soil Fertility Handbook*.

Long term value of manure

Use soil tests to estimate the long-term availability of phosphorus, potassium, magnesium, zinc or manganese from previous manure applications. Application of large quantities of manure over time can result in high levels of available P and K in soils. Manure also contributes other plant nutrients and organic matter to soil that may be of some long term value.

Most of the available nitrogen in manure is used by the crop or lost during the first growing season following application. The remaining organic nitrogen becomes available in small, diminishing quantities in succeeding years. Generally the amount of residual nitrogen from one application is too small to make a practical difference in nitrogen recommendations for a crop. However, where manure is applied regularly to the same field, there can be significant residual nitrogen available for a crop.

Environmental concerns with manure

Take care to avoid manure contamination of streams and groundwater. Surface water contamination can occur from erosion, surface and tile runoff. Groundwater contamination can occur when nutrients are applied in excess of crop requirements, particularly on shallow soils over bedrock, soils with a water table close to the surface or very sandy soils. Groundwater contamination can also occur by mass flow through cracks and holes to groundwater or spreading too close to wells or through leaching of nitrates through the soil.

- Use manure at rates that meet, but do not exceed, crop nutrient needs.
- Do not spread manure in the winter and early spring because of the potential for runoff to surface water. The fate of the first meltwater following manure application determines whether this will be a problem or not. This practice should not be a part of a nutrient management plan. In years when winter spreading may be necessary, select fields where there is no risk of runoff to surface water.

- Rain can cause organic nitrogen to wash into streams if manure has been applied to unprotected cropland. Phosphorus, attached to soil particles, can be carried to streams by soil erosion. Use soil conservation practices to reduce the chances of nutrients polluting waterways.
- Liquid manure poses unique problems and challenges to minimize environmental risk. Refer to OMAF Publication 811, *Agronomy Guide for Field Crops* for liquid manure application guidelines.

Food safety concerns with manure application and timing

Fruit and vegetable crops can become contaminated in the field if they contact microbes that cause human disease. These microbes can come from manure fertilizers and manure-based composts. They can contaminate fruit or vegetables by direct soil-to-produce contact or through rain-splashed soil. Examples of harmful microbes are some, but not all, strains of *E. coli*, *Salmonella* and *Campylobacter*.

The longevity of harmful microbes in manure is not well known. Proper composting of manure, which involves heating to a specific temperature for a specific period of time, reduces the level of most pathogens. Aged manure (manure stored in piles and sometimes turned) may contain considerably more pathogens than properly composted manure (manure turned or mixed frequently, temperature monitored and maintained). Composting may not completely eliminate all pathogens. Take appropriate precautionary measures. Consider the following strategies to maximize the time between application of manure and harvest:

- Apply manure postharvest and incorporate after application. Incorporation of manure will minimize, but may not eliminate, the risk of microbial contamination of produce.
- Apply manure to a fall cover crop.
- Plan crop rotations so manure is applied to crops that are to be cooked or processed.

Manure application to fruit and vegetable crops is not recommended before harvest, in the year of harvest.

Concerns about food safety and the possible introduction of food borne pathogens to windfall apples by application of manure to the orchard floor is discussed in the *Code of Practice for the Production and Distribution of Unpasteurized Apple and Other Fruit Juice/Cider in Canada* compiled by the Canadian Food Inspection Agency (CFIA). This is available on the CFIA web site at *www.inspection.gc.ca*. Contact the CFIA office for general inquiries at 519-837-9400.

Where apples may be used for juice or cider, it may not be appropriate to apply fresh or composted manure to the orchard. Food borne pathogens can be introduced into orchards via manure and these pathogens can be a significant threat in the contamination of apples used to produce unpasteurized juice or cider.

Fertilizer Materials

All fertilizer salts are toxic to germinating seeds and to plant roots if applied in sufficient concentration near the root. Fertilizers vary in toxicity due to:

- differences in the amount of salts contained in the fertilizer
- differences in solubility of the salts in the soil
- a few specific materials or elements that are particularly toxic (for example, ammonia and boron).

The most common nitrogen fertilizers used in fruit crops are calcium ammonium nitrate, ammonium nitrate, calcium nitrate, urea and ammonium sulphate. In most cases different sources produce equal yields. Choose nitrogen fertilizer based on availability, equipment for handling and cost per hectare of nitrogen, plus the cost of application. Consider:

- the cost per kilogram of nitrogen from various sources delivered to the farm
- the cost per hectare, based on application rate
- the cost of application per hectare.

Where separate additions of nitrogen are referred to in the recommendations, kilograms of elemental nitrogen (N), not kilograms of materials, are used.

Table 3–7, *Fertilizer materials — secondary and micronutrients*, page 34 and Table 3–8, *Fertilizer materials — primary nutrients*, page 34 show the percentage of fertilizer nutrient contained in different materials. Various fertilizer companies have available, in addition to the micronutrient sources listed in Table 3–7, premixes containing one or more micronutrients.

TABLE 3–7. Fertilizer materials — secondary and micronutrients

Magnesium (Mg)	
Dolomitic limestone	6%–13% Mg
Epsom salts (magnesium sulfate)	10.5% Mg
Sulfate of potash magnesia	11% Mg
Boron (B)	
Sodium borate	12%–21% B
Copper (Cu)	
Copper sulfate	13%–25% Cu
Copper chelates	5%–13% Cu
Manganese (Mn)	
Manganese sulfate	26%–28% Mn
Molybdenum (Mo)	
Sodium molybdate	39% Mo
Zinc (Zn)	
Zinc sulfate	36% Zn
Zinc chelates	7%–14% Zn
Zinc oxysulfate	18%–36% Zn

TABLE 3–8. Fertilizer materials — primary nutrients

Nitrogen materials	Form	% Nitrogen (N)
Ammonium nitrate	Dry	30–34
Urea	Dry	45–46
Calcium ammonium nitrate	Dry	23
Calcium nitrate	Dry	15.5
Ammonium sulfate	Dry	20
Aqua ammonia	Liquid[1]	20
Urea-ammonium nitrate	Liquid[1]	28
Anhydrous ammonia	Liquid[1]	82
Phosphate materials	**% Phosphate (P_2O_5)**	
Single superphosphate	20	
Triple superphosphate	44–46	
Monoammonium phosphate	48–52	
Diammonium phosphate (18-46-0)	46	
Potash materials	**% Potash (K_2O)**	
Muriate of potash	60–62	
Sulfate of potash	50	
Sulfate of potash magnesia (11% Mg)	22	
Potassium nitrate (13-0-44)	44	

[1] Liquid under pressure

Soluble salts in farm soils

High concentrations of water-soluble salts in soils can prevent or delay germination of seeds. They can either kill transplants and established plants or seriously retard their growth.

Soluble salts rarely cause a problem in crop production because Ontario soils are naturally low in soluble salts. They are not routinely measured in soil tests.

High concentrations of soluble salts can result from:

- excessive applications of fertilizers and manures
- runoff of salts applied to roads
- chemical spills on farm land.

High concentrations of soluble salts in or near a fertilizer band can seriously harm plant growth without affecting the salt concentrations in the remainder of the soil. Excessive soluble salts damage plants by restricting water uptake and pulling water out of plant tissues. Salt concentration in soil increases as water supply decreases. For this reason, plant growth is most affected by soluble salts in periods of dry weather, and in soils with low moisture holding capacity.

Soluble salts can be measured in the laboratory by measuring the electrical conductivity of a soil water slurry. The higher the concentration of water-soluble salts, the higher the conductivity. Table 3–9, *Soil conductivity reading interpretation* interprets soil conductivity readings.

TABLE 3–9. Soil conductivity reading interpretation*

Conductivity "salt" reading millisiemens/cm	Rating	Plant response
0–0.25	L	Suitable for most plants if recommended amounts of fertilizer are used.
0.26–0.45	M	Suitable for most plants if recommended amounts of fertilizer are used.
0.46–0.70	H	May reduce emergence and cause slight to severe damage to salt sensitive plants
0.71–1.00	E	May prevent emergence and cause slight to severe damage to most plants.
1.00	E	Expected to cause severe damage to most plants.

* Where conductivity is measured in a 2:1 water:soil paste for Ontario field soils, using OMAF-accredited procedures.

Fertilizer placement

Phosphorus is important for early growth. It is more available if placed near or in the root zone. For transplanted crops, use a high phosphorus starter solution.

Nitrogen fertilizers readily dissolve in soil water and move easily through soil to plant roots. Placement of nitrogen is less important than for phosphorus. Part of the nitrogen requirement is usually broadcast, injected or worked into the soil before planting, often to hasten the breakdown of the cover crop. In strawberries, a portion of the nitrogen can be side-dressed after planting, rather than applied all at once before planting. This minimizes leaching and prevents too much early vegetative growth at the expense of roots.

Too much potassium applied in a band at planting or in the transplant water can injure young transplants. This danger of fertilizer injury is greater on sands and sandy loams than on silt loam and clay loam soils. On coarse textured sand and sandy loams, broadcast and work part of the potassium fertilizer requirements into the soil before planting.

Water Quality

Water is a valuable resource. A clean and abundant supply of water is critical to the success of your farm business and the health of your family. Others, including fish and wildlife, also share water. You have a right to expect an ample supply of clean water, and it is your responsibility to make sure the water leaving your farm is abundant and clean for the next user.

Farm operations affect water quality in many ways. Soil erosion, manures, septic system effluent, milkhouse wastes, horticultural wash waters, pesticides and fuels can affect surface water quality. Nutrients, manures, pesticides and fuels moving down through the soil into the groundwater can affect groundwater quality.

The greatest water quality challenges affecting farmers involve bacteria (from manures), nitrates and sediment. The following problems can be minimized using the practices listed.

Bacteria contamination

- Contain runoff from manure storages, livestock yards and silos.
- Avoid spreading manure on frozen or snow-covered ground.
- Make sure your well is properly maintained and protected from surface contamination.
- Properly treat or store milkhouse waste water or wash water.
- Ensure your domestic septic system is working properly and is not discharging into a drainage system.

Soil erosion

- Adopt conservation tillage practices.
- Install erosion-control structures.

Nitrate contamination

- Complete a nutrient-management plan for your farm. This will account for all nutrient sources. See OMAF Publication 818, *Nutrient Management Workbook* or on the OMAF web site at *www.omaf.gov.on.ca*.
- Avoid spreading excessive amounts of manure or fertilizer on a field.

Pesticide contamination

- Store pesticides properly and keep as little as possible in storage.
- Stay away from ditches and other sources of water when spraying.
- Clean up spills quickly and thoroughly.
- Be careful not to mix more pesticide than required.

Fuel contamination

- Store fuel away from wells, ditches, etc.
- Use automatic shut-off nozzles to prevent spills.

The following Best Management Practices publications contain more information on water quality problems and solutions, soil conservation measures, and nutrient and manure use.

Best Management Practices

Field Crop Production, BMP 02
Irrigation, BMP 08
Nutrient Management, BMP 05
Pesticide Storage, Handling and Application, BMP 13
Soil Management, BMP 06
Water Management, BMP 07
Water Wells, BMP 12

These publications are available through the Ontario Federation of Agriculture, which can be reached by telephone: 416-485-3333, fax: 416-485-9027 or through the OMAF Products Catalogue on the web site at *www.omaf.gov.on.ca*. See Appendix I, ***Best Management Practices Booklets and Ordering Information***, page 242.

Managing Soil Organic Matter

Soil organic matter helps:

- maintain soil structure and tilth
- improve soil moisture holding capacity
- increase the soils ability to hold nutrients
- improve internal drainage.

Maintaining adequate soil organic matter levels can help maintain crop yields, particularly in years with bad weather.

Increasing soil organic matter is a slow process. Only a small part of organic matter added to the soil becomes stable humus. It is important to keep as much organic matter in the soil as possible by:

- reducing soil erosion
- eliminating unnecessary runoff
- avoiding excessive tillage.

Organic matter additions also, over time, increase the total soil organic matter. These may be in the form of livestock manures, biosolids, forage crops or cover crops. Cover crops recommendations for fruit crops are discussed in ***Cover Crops and Ground Cover Management***, below and ***www.omaf.gov.on.ca***.

COVER CROPS AND GROUND COVER MANAGEMENT

Adaptation and Use of Cover Crops

Fruit growers can use a variety of ground cover management systems to help manage crop growth, yield and quality while protecting their valuable soil resource. At different times during the production cycle, various cover crops or ground cover management systems may be useful. Site preparation, planting, plant establishment, fruit quality and winter hardiness can all be improved by choosing the appropriate use of ground covers.

Cover crops and green manures help to:

- capture residual soil nitrogen
- maintain soil organic matter levels.

Cover cropping is an important strategy for nutrient management and for the reduction of greenhouse gas emissions.

Below is information on some of the more commonly-used cover or green manure crops.

Grasses

Grasses have fine, fibrous root systems that are well suited to holding soil in place and improving soil structure. Suitable grass species for cover crops are fast growing and relatively easy to kill — chemically, mechanically or by winter weather. Grasses do not fix any nitrogen out of the atmosphere, but they can accumulate large quantities from the soil.

Spring cereals

Oats and barley are commonly used as green manure and cover crops. Stands seeded between mid-August to mid-September will have 20–40 cm of growth by freeze-up. While seeding can be done outside this time frame, heat and lack of moisture in the summer may interfere with germination. The stand is generally killed by late, hard frosts.

Cautions: Early seeding may result in considerable growth by freeze-up. This can form a mat of dead residue if left untilled. In the spring, this can keep soil cold and wet, interfering with spring tillage.

Ryegrass (annual, Italian or perennial)

Direct seed in spring or from August to mid-September, or seed with a nurse crop in spring. Ryegrass has also been broadcast into corn in late June to early July with some success. Annual ryegrass gives the most top growth in the seeding year, often heading 6–8 weeks after seeding. Italian ryegrass (a biennial) does not head in the seeding year, so top growth is considerably less. However, it has the largest, most dense root system of the 3 types. Annual and Italian ryegrasses usually suffer considerable winterkill, but part of the stand may survive. Perennial ryegrass normally survives the winter.

Cautions: Establishment and growth of ryegrasses can be poor during very hot, dry weather. It can be difficult to kill overwintering ryegrass with only cultivation or discing. The nitrogen tied up in ryegrass releases more slowly than from other cover crops.

Winter wheat

Winter wheat can be seeded in late August through October. It can be seeded outside this time but, similar to spring cereals, weather conditions may reduce top growth. Wheat survives overwinter and begins growing in April. The stand can be killed through tillage or herbicide application. The plant shuts down earlier in fall and begins to grow later in the spring.

Cautions: Generally winter wheat does not return as much green material to the soil as rye, nor does it give the level of weed competition that rye provides.

Winter rye

Winter rye is seeded from late August to mid-October, often following field or vegetable crops. It grows until freeze-up, and then begins growth again in March to early April (slightly earlier than winter wheat). Growth rate is very rapid during May. The stand is generally killed in late April or early May by tillage or herbicide use. Rye can produce significant root and top mass for return to the soil. A rye cover crop suppresses winter annual weeds effectively. Winter rye can be seeded later than any other crop and still survive over winter. For good ground cover and erosion protection, seed at least a month before freeze-up.

Cautions: Kill rye in the fall or early spring to avoid loss of soil moisture and difficulties in incorporation. Rye is an excellent host for root-lesion nematode.

Sorghum sudan

Sorghum sudan is an excellent choice for growing as a green manure crop to improve the soil. Root growth is extensive and top growth lush. A preplant herbicide treatment is recommended for crop establishment. Plant in mid-June, after all threat of frost is past. The crop benefits from the warm temperatures of early to mid-summer. Approximately 50 kg/ha of N helps the crop achieve maximum top growth. Some varieties have nematode suppressing properties. These varieties do not have to be incorporated green for nematode suppression.

Cautions: Mow sorghum sudan before it reaches 1 m in height. This encourages tillering and ensures stalks are not woody and slow to break down. More than 1 year of a nematode suppressing cover crop may be required to successfully reduce nematode populations.

Forage pearl millet

Forage pearl millet is a warm season grass and is extremely sensitive to frost. It can produce a significant amount of top growth. This makes it a good choice as a mid summer green manure crop to improve the soil. Root growth is extensive. A preplant herbicide treatment is recommended for crop establishment. Plant in mid-June, after all threat of frost is past. The crop benefits from the warm temperatures of early to mid-summer. Approximately 50 kg/ha of N helps the crop achieve maximum top growth. Planting certain cultivars of forage pearl millet in rotation with high valued horticultural crops can reduce nematode populations below economic thresholds. Canadian Forage Pearl Millet 101 reduces nematode populations by inhibiting the ability for nematodes to reproduce in its root system. The pearl millet does not have to be incorporated green for nematode suppression.

Cautions: Mow pearl millet before it reaches 1 m in height. Do not mow shorter than 15 cm to ensure regrowth. This encourages tillering and ensures stalks are not woody and slow to break down. More than one growing season of this cover crop is necessary for nematode suppression.

Legumes

Legume cover crops can fix nitrogen from the air, supplying nitrogen to the succeeding crop as well as protecting the soil from erosion and adding organic matter. The amount of nitrogen fixed varies between species, although generally, more top growth equals more nitrogen fixed. Some legume species have aggressive tap roots that can break up subsoil compaction, but this requires more than one year's growth to happen.

Legumes are not commonly used as cover crops for fruit crop production because they provide an inconsistent and season-long release of nitrogen. Too much nitrogen at the wrong timing can interfere with fruit quality and winter hardiness of fruit crops. Legumes may flower at the same time as fruit crops and cause competition for bees and other pollinators. Legumes are also attractive to tarnished plant bugs and most are excellent hosts for nematodes. Where legumes are used in organic production, harvesting must be carefully timed to minimize pest issues. Legume cover crop species are covered in the OMAF Publication 811, *Agronomy Guide for Field Crops* and on the OMAF web site at *www.omaf.gov.on.ca*.

Non-legume broadleaves

These broadleaf crops may have a role as green manure crops and in providing different plant species and root systems for soil building. They cannot fix nitrogen out of the air, but they can absorb large quantities from the soil. None of these crops are winter-hardy, so additional control measures are not normally required. Do not allow them to go to seed, as the volunteer seed can become a significant weed problem.

Buckwheat

As a cover crop, buckwheat is most commonly seeded in late June to early August. It grows very rapidly, reaching flower stage and a height of 45–75 cm in about 6 weeks. It has a relatively small fibrous root system and is completely killed by the first frost. Buckwheat provides rapid soil cover, gives good erosion protection during the growing season, smothers annual weeds and suppresses perennial ones. Moderate amounts of fresh organic matter are returned to the soil.

Cautions: Late summer seedings may be killed by an early frost before providing significant growth. Buckwheat is an excellent host for root-lesion nematode. Buckwheat starts to set seed at 6 weeks.

Oilseed radish

Oilseed radish is commonly seeded in August or early September. It is unaffected by early frosts and can grow to a height of 50 cm by October. The plant has a thick, but short taproot, varying between carrot and turnip shaped. It is killed by severe frosts in late November or December. Oilseed radish provides a reasonably rapid soil cover and excellent erosion protection over winter. It returns moderate amounts of organic matter to the soil. For good growth, this crop must have a large amount of available nitrogen. Some oilseed radish cultivars can help to reduce plant parasitic nematode soil populations below economic thresholds. The nematode suppressing cultivars of oilseed radish and certain mustards must be incorporated into the soil as a "green manure" crop before they will release isothiocyanate into the soil that is toxic to plant parasitic nematodes.

Cautions: Growth will be poor if soil nitrogen levels are low or if soil compaction is severe. Scattered volunteer plants usually appear in most crops planted after oilseed radish. Some varieties may have a greater tendency to survive winter conditions. More than 1 year of a nematode suppressing cover crop may be required to successfully reduce nematode populations.

Marigolds

Marigolds can be a useful cover crop for nematode suppression. Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil directly. Research has suggested nematode suppression from these cultivars can be achieved for up to 2 years. Shallowly seed marigolds in the spring once soils have warmed. Achieving a dense weed-free stand is essential to success in nematode suppression. Use of the stale seedbed technique for weed control has been successful. For full effect the marigolds should be grown for a full cropping season.

Cautions: Seeding of this cover crop is difficult as the seed tends to bridge in the drill tubes. Seed is expensive. Herbicide options are limited.

For more detailed information on cover crop use and management refer to the OMAF web site *www.omaf.gov.on.ca*.

Sod Covers for Orchards, Vineyards and Brambles

One of the best ways of protecting and supplying organic matter, controlling erosion and reducing late season growth, is using a cover crop. There are 2 approaches to cover crops: one temporary; the other permanent.

Temporary

A temporary cover crop is seeded late in the season. Stop cultivation by June 1 in peach orchards, July 1 in other orchards and cane fruit plantings, and by August 1 in vineyards. A cover crop such as annual Italian ryegrass can then be seeded at the rate of 13–17 kg/ha. Use a soil test to determine optimum fertilizer rates or fertilize with 100 kg/ha 10-20-20 before seeding to promote growth and organic matter production. This crop is incorporated into the soil early next spring.

Permanent

For permanent sod covers, many different species of grass can be used. Choose a grass that is:

- not overly vigorous
- resistant to traffic damage in early spring and late fall
- drought resistant
- not a good habitat for voles and mice.

Short growing turf-type fescues (tall or creeping red) make excellent sods and also offer some suppression of nematodes. To aid germination, seed as shallow as possible at the rate of 20–22 kg/ha in later August or September. Prepare and fertilize the soil well, according to soil test results or with 100 kg/ha 10-20-20 before seeding. Sod mixtures containing grasses and legumes can also be used, but inclusion of forage legumes may result in the untimely release of nitrogen and concerns with pest management.

Use permanent sod covers in stone fruit orchards only where irrigation is available.

For more crop specific information see OMAF Factsheet *Soil Management for Orchards and Vineyards*, Order No. 92-120.

TABLE 3–10. Characteristics of green manure crops and cover crops grown in Ontario

Species	Normal seeding time	Seeding rate (kg/ha)	Nitrogen fixed	Nitrogen uptake[3]	Overwintering characteristics	Potential weed problem from volunteer seed	Supports nematodes[1]	
							Lesion	Root-knot
Grasses								
Ryegrass	mid-July–Aug.	13–17	no	medium	overwinters	no	—	—
Spring cereals (oats, barley)	mid-Aug.–Sept.	100–125	no	medium	killed by heavy frost	no	+	—
Sorghum sudan	June–Aug.	50	no	med.–high	killed by frost	no	—	
Pearl millet	June–Aug.	9–10	no	med.–high	killed by frost	no	—	0
Winter wheat	Sept.–Oct.	100–125	no	med.–high	overwinters well	no	+	—
Winter rye	Sept.–Oct.	100–125	no	high	overwinters very well	no	+[2]	—
Legumes	April–June	species dependent	yes	low	most overwinter	usually not	— to +++	— to +++
Non-legume broadleaves								
Oilseed radish	mid-Aug.–early Sept.	10–14	no	high	killed by heavy frost	yes	—	—
Marigold	May–June	1.3	no	low	killed by heavy frost	usually not	—	—
Buckwheat	June–Aug.	50–60	no	low	killed by first frost	yes	+++	—

[1] Varietal differences in cover crop species may affect nematode reaction.
[2] Rye — whole season rating would be higher (+++).
[3] The potential for nitrogen uptake by individual cover crops is influenced by seeding date, stand and weather.
NEMATODE RATING CODES: (—) poor or non-host; (+) ability to host; (0) some cultivars are non-hosts

4. Pest Management

Integrated Pest Management

Integrated pest management (IPM) is an approach to pest control that considers all management options to maintain pests below an economic injury level. It does not advocate a continuous pesticide spray program to eradicate pests, but promotes the integration of cultural, biological and chemical control strategies. Adverse effects of pesticides on the environment are minimized and economic returns are maintained.

To implement an IPM program you must have a thorough knowledge and understanding of:

- pest identification, biology and behaviour
- beneficial organisms
- monitoring techniques
- use and timing of appropriate management tools
- record keeping
- resistance management strategies.

This publication outlines the use and timing of pesticides, cultural management tools and resistance management strategies.

More detailed information on pest identification, biology, trapping, monitoring and record keeping techniques can be found in OMAF Factsheets and publications such as Publication 310, *Integrated Pest Management for Ontario Apple Orchards* and Publication 513, *Growing Strawberries in Ontario*.

Current information is also available on the crop page of OMAF's web site *www.omaf.gov.on.ca*. Additional information is available in newsletters, meetings, scout training sessions and pest management workshops.

Thresholds

An IPM program uses control guidelines or thresholds to indicate when to apply pesticides to prevent economic losses. Timing of control measures is critical. Guidelines for insect pests are based on an economic threshold where the lost income from not managing a pest will be higher than the cost of applying a control. In other words, some damage to the crop is tolerated as long as this damage does not exceed the cost of the control. Guidelines for diseases, weeds, nematodes and vertebrates may be based on weather, site history, stage of crop development and field observations.

Pest monitoring

Monitoring is a critical component of a successful IPM program. Monitoring allows you to forecast and evaluate potential pest problems. Effective monitoring identifies the pest present, estimates numbers and examines conditions favourable to pests. Monitoring allows accurate timing of pest control measures, thus reducing pesticide use. Regular monitoring also helps to identify minor or secondary pest populations before they can cause significant damage.

Monitor at least once a week and preferably twice a week when the pest is most active. Good record keeping is essential. Keep a site map and record the stage of crop development, population levels of pests and beneficials, damage observed, the location of damage, weather and other environmental conditions, and the sprays and other control measures used.

Monitoring can include the use of pheromone and sticky traps, weather recording equipment, and visual observation or scouting. For a list of monitoring equipment suppliers, see Appendix F, *Suppliers of Pest Monitoring Equipment and Biological Control Agents*, on page 238.

Trapping

Trapping insects can provide information on pest activity and, to a lesser degree, numbers. Trap counts can be used to validate degree-day models predicting insect emergence. Using traps can optimize the timing of pest control products and improve the effectiveness of pest management programs. Most traps catch only the adult stage of the pest and may not provide information on the damaging larval stage.

Pheromone traps are used to collect information on activity of a specific pest. Volatile chemicals emitted from female insects to attract males are known as sex pheromones. For some insects these unique chemicals have been identified and synthetically produced into lures, which are placed in sticky traps. Pheromone traps are attractive to only the male insects of a particular species. They do not provide information on the population levels of other pests.

Yellow sticky boards and red spheres are attractive to certain insects by providing a visual stimulus. The colour of these traps reflects lights of certain wavelengths, recognized by the insect. These traps are not species specific, but can be used to indicate the presence and relative abundance of several flying insects.

- Place traps in the field 1 to 2 weeks prior to the expected emergence of the insect. The number of traps used and the location of the traps within the crop is important, and varies with the crop and insect being monitored. Specific monitoring guidelines are available in the publications listed in the box on page 41.
- The pheromone lures are specific to the pest being trapped. They are very sensitive to contamination if they come in contact with other types of pheromones. If your trapping program involves using different types of pheromones, wear disposable latex gloves to prevent cross-contamination during handling. Maintain a minimum distance of 40 m between pheromone traps to prevent cross contamination.
- Use flagging tape to clearly mark the location of traps so they can be located throughout the season. Check traps twice weekly, recording the number of moths caught. Remove the insects during each visit. Replace the trap when it becomes too dirty or no longer sticky.
- When replacing traps, simply transfer the old lure into the new trap. Replace the lures according to the manufacturer's instructions; some pheromone lures require replacement every 6–8 weeks. Store unused pheromone lures in the refrigerator. When trapping for several insects, use separate traps for each species and label traps clearly with the pest's name.

Degree-day modelling

Degree-day calculations, or DDC, are used to estimate the growth and development of pests during the growing season. For example, degree-day calculations can predict the first flight of codling moth adults or the percentage of apple scab ascospores that have matured in the orchard.

Insect and plant development depend on temperature. As an organism develops over a growing season, its development is closely related to the daily accumulation of heat. A certain amount of heat is required to provide enough energy for the organism to move to the next development stage.

The amount of heat required to move to the next development stage remains constant from year to year, but depending on weather conditions, the amount of actual time can vary. Each organism has a minimum base temperature or threshold below which development does not occur. These base temperatures have been determined experimentally and are different for each organism.

Degree days are calculated as follows:

$$\text{DDC} = \frac{[(\text{Daily max}^\circ\text{C})+(\text{Daily min}^\circ\text{C})]}{2} - \text{base temperature}$$

While DDC are useful in predicting development of many insects and diseases, there are limitations to degree-day models.

- Factors such as humidity, light intensity and accumulated rainfall also affect pest development. As a result DDC predictions are only estimates of pest development, which must be validated with field observations.
- Temperatures used to determine DDC must represent the environment where organisms are developing. Using weather data from sites more than a mile away will reduce the accuracy of the model and not give an accurate estimate of the pest development.

Information on the use of degree-day models for specific pests can be found in OMAF Factsheets and publications.

Scouting and sampling

Visual inspections keep track of the number of insects or the amount of disease actually present in the crop.

- When scouting the crop, inspect plants in several areas across the field to get an accurate idea of pest pressure.
- Improve scouting efficiency by using tools such as hand lens, tapping trays and sweep nets.
- Give special attention to monitoring border areas and wild fruit trees adjacent to or near orchard

perimeters. These areas are favoured overwintering sites for many insect pests.

Sampling involves collecting data to represent the entire planting being monitored.

- Divide large areas into sampling blocks no larger than 8–10 ha. The cultivar, training system, plant density, soil type, topography and age of the planting should be as consistent as possible in each sampling block.
- Monitor blocks of older trees and new plantings as separate units.

Pest activity and emergence may vary with the time of day. Whenever possible, monitor and sample at the same time of the day.

For a list of crop consultants providing monitoring services, contact OMAF's Agricultural Contact Centre at 1-877-424-1300.

Pest management measures

Cultural and mechanical pest controls

Integrated pest management incorporates the use of cultural and mechanical practices to prevent or delay the development of pest outbreaks. Management tools include:

- **Site selection**: Choose sites less favourable for pest development.
- **Resistant or tolerant cultivars**: Select cultivars less susceptible to disease or insect pressure.
- **Crop rotation**: Some insects and diseases overwinter in crop refuse. Rotating to a non-related crop where possible may help to break the pest cycle.
- **Certified planting/nursery stock**: Use disease or virus free plants to reduce the likelihood of losses.
- **Sanitation**: Remove all sources of infection (cull piles and dropped fruit) from the field or orchard.
- **Eliminate alternate hosts**: Weeds and wild fruit trees, grapevines and brambles often act as alternate hosts to many crop pests. Maintain good weed control and eliminate wild hosts from the perimeter of the planting.
- **Inter-cropping**: Avoid inter-cropping plants with similar pest complexes. Non-related crops planted in close proximity can act as a barrier to insects and diseases.
- **Habitat modification**: Plant cover crops to promote beneficial organisms.
- **Pruning and training**: Prune and remove infected plant material to reduce pest pressure. Pruning and training plants to improve air movement within the canopy, will also improve spray coverage.
- **Water management**: Avoid planting in poorly drained locations. Timely irrigation can reduce plant stress during drought and increase plant tolerance to pests.
- **Nutrient management and plant health**: Manage nutrients to avoid excessively lush terminal growth, which attracts some pests.

Chemical controls

Chemical controls include synthetic, inorganic, botanical and biological pesticides. They kill target pests and limit subsequent populations. They are important tools for crop protection when used in an IPM program.

Understand the pest's life cycle and apply chemicals at the stage when the pest is most vulnerable.

- To control insects, monitor blocks closely and spray according to action thresholds established for each insect.
- To control disease, apply protective fungicides when weather conditions are favourable and before damage occurs. The application of a well-timed pesticide can provide effective control of pest populations and delay the development of pesticide resistance.

Biological control

Biological control uses a pest's natural enemies to help suppress pest populations. Biological controls include predators, parasites and pathogens, also known as "beneficials". Once established, they can maintain pest populations at lower levels. They are effective at controlling indirect pests such as aphids, leafhoppers and mites. They are less effective at keeping populations of direct pests (those attacking the harvested product) at levels acceptable for commercial production. One of the advantages of beneficial insects is that their activities can prevent or delay the development of pesticide resistance.

IPM programs attempt to minimize adverse effects on beneficials and take advantage of the pest management provided by these insects. Understanding the life cycles of beneficials can improve the timing of spraying, cultivating, mowing and harvesting so that an adequate population of natural enemies can survive. Important beneficial insects in Ontario fruit crops include ground beetles, mullein bugs, minute pirate bugs, lacewings and lady bird beetles.

For additional information on predators and parasitoids, consult OMAF Publication 208, *Predatory Insects in Fruit Orchards,* OMAF Factsheet ***Beneficial Insects in Tree Fruit Orchards in Southern Ontario***, Order No. 96-029 and OMAF Publication 310, ***Integrated Pest Management for Ontario Apple Orchards.***

Pathogens

Beneficial pathogens — bacteria, fungi, viruses and nematodes — are naturally present in the crop environment. Commercially available formulations of bacteria (*Bacillus thuringiensis* or B.t.) are also available. For a list of recommended pest control products, see the specific crop calendars contained in this guide.

Mating disruption

Many adult insects emit volatile chemicals known as sex pheromones to attract members of the opposite sex. When a female moth secretes these chemicals, males use the pheromone trail or "plume" to pinpoint her location. Synthetically produced sex pheromones can be used in traps to monitor insect activity patterns. Mating disruption (MD) technology uses these same chemicals to confuse males and limit their ability to locate calling females. The release of large quantities of synthetic sex pheromone into the crop atmosphere interferes with mate location by masking the trail or pheromone plume. Mating is either delayed or prevented because the probability of males finding females is reduced. Consequently, fewer larvae are present to cause crop damage. Synthetic pheromones used in mating disruption are a form of biological control.

For additional information on synthetic pheromones and their use in pest management, see *Mating Disruption (MD) Technology for Management of Grape Berry Moth* on page 165, apples ***Oriental fruit moth*** on page 91 and tender fruit ***Oriental fruit moth*** on page 181. The OMAF Factsheet ***Mating Disruption for Management of Insect Pests,*** Order No. 03-079 is also available.

Pest Resistance to Insecticides, Fungicides, Miticides

Pests are resistant when they survive exposure to pesticides at rates that previously controlled them. Generally, resistance to a pesticide develops after repeated exposure to a specific chemical. Sprays applied to control one pest can affect the status of resistance of other pests within the complex.

Resistance occurs because a few naturally occurring resistant individuals survive after each spray, while the susceptible portion of the population is killed. These resistant survivors multiply and gradually replace the susceptible ones. Eventually the resistant population dominates, and the pesticide loses its effectiveness.

Resistance to pesticides can develop very quickly. Do not use the same chemical repeatedly unless used in rotation with a different chemical or in combination with other chemicals having a different mode of action. In some cases when a pest becomes resistant to a chemical or chemical family it will not become susceptible again, even if that chemical is discontinued for many years (stable resistance). In other cases a resistant population becomes susceptible again over time (non-stable resistance).

Be aware that chemicals with the same active ingredients or same mode of action are marketed under different brand names. As well, different chemicals may have the same mode of action. For example both Nova and Nustar act on the same site in the fungus and, therefore, have the same mechanism of control. Using Nova after Nustar is equivalent to using Nova after Nova, since resistance develops to both chemicals at the same time, even though only one may have been used repeatedly. The same applies for many pyrethroids.

For a list of products, their active ingredients and chemical family see Table 4–1, *Insecticide and miticide groups based on sites of action*, on page 46 and Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.

Insecticides

Organophosphates

Resistance to this group of insecticides occurs in a number of major pests, namely tentiform leafminer on apples, oblique-banded leafroller on apples and pears, pear psylla on pears, and oriental fruit moth on peaches, nectarines and apples. Other orchard pests may have low levels of resistance to this group of compounds, but this is largely unconfirmed.

Over the last few years, tests have demonstrated variable levels of resistance to Imidan and Guthion in oblique-banded leafroller populations in apple, pear, raspberry, sweet cherry and peach plantings across southern Ontario. Resistant populations have been identified in the regional municipalities of Niagara and Durham, and the counties of Essex, Kent, Northumberland and Grey.

In most areas of Ontario there is now confirmed resistance to some organophosphate (OP) insecticides (including Imidan, Parathion, and Guthion/APM) in oriental fruit moth (OFM) populations. The level of resistance to these insecticides has dropped where growers have used Lorsban and pyrethroids as part of an IPM program. Resistance to Guthion and Imidan does extend to pyrethroids or Lorsban. Low levels of pyrethroid resistance have been identified and growers are advised to use these in a rotation with Lorsban for insects including the oriental fruit moth.

Pyrethroids

The present status of spotted tentiform leafminer (STLM) and pear psylla resistance is unknown; resistance monitoring has not been conducted since the early 1990s. Previous studies demonstrated that STLM adults became resistant to all pyrethroids (Pounce, Decis, Cymbush and Ripcord) in many apple orchards in Ontario when exposed to repeated applications of these chemicals. Pear psylla resistance to pyrethroids has been documented in western North America and some pear orchards in the Niagara Peninsula. Resistance may occur in other parts of the province.

Surveys for resistance to oriental fruit moth (OFM) have been conducted at 6 locations in the Niagara region and 1 location in Essex County. Four years (1994–1998) of results indicate that resistance to pyrethroids in adult OFM were at a low frequency. Expression of resistance in larvae at these low levels has not resulted in control failures in the field when insecticides were timed correctly to control hatching OFM larvae in peaches. The short-term resistance management strategy of using Lorsban only for 1st generation and pyrethroid insecticides for the 2nd to 4th generations was successful. This program has stabilized or reduced the numbers of OFM moths resistant to pyrethroids.

For other tree fruit, the repeated use of pyrethroid insecticides (more than once per season) is discouraged because of the potential for further resistance development, and because pyrethroids are toxic to beneficial insects and mites.

Lannate

The status of resistance to Lannate has not been determined since the early 1990s. Several cases of STLM resistance to Lannate have been documented in Norfolk County, as well as other apple growing counties. Avoid this product where such resistance exists.

Fungicides

Benlate/Senator

Cases of resistant apple scab have been documented in most of the apple growing areas of the province.

Equal

Apple scab is resistant to Equal (and a previously marketed formulation known as Cyprex) in a moderate percentage of orchards in Ontario. Resistance to Equal persists for many years. This chemical no longer controls apple scab once resistance is established.

Rovral

Botrytis, the causal agent of bunch rot of grapes, has developed resistance to Rovral in many vineyards after 4 years of use. Resistance is expected to develop to grey mould in strawberry fields as well. However, the resistant form of the fungus does not survive well and declines when Rovral is not used for several years. If Rovral is only used once or twice per season, but not consecutively, resistance should remain at low levels and Rovral should remain effective.

Tests on *Monilinia fructicola*, the causal agent of brown rot on cherries, plums, peaches and nectarines, indicate there are no resistant populations in Ontario. However, there are resistant populations in New Zealand and Australia. Therefore, do not use Rovral more than twice per season. This helps prevent resistance.

Rovral has 3 main methods of action against brown rot:

1. **Protection activity**: The fungicide prevents infection from occurring when the residue is on the surface prior to the infection period.

TABLE 4–1. Insecticide and miticide groups based on sites of action

The classification scheme was developed in consultation with the Insecticide Resistance Action Committee (IRAC).

Group	Chemical family/group	Product name	Active ingredient
1	Carbamate	Carzol SP	formetanate hydrochloride
		Furadan 480F	carbofuran
		Lannate	methomyl
		Pirimor 50 DF	pirimicarb
		Sevin XLR Plus	carbaryl
		Vydate L	oxamyl
	Organophosphate	Cygon 480–Ag	dimethoate
		Diazinon 50 W	diazinon
		Diazinon 500E	diazinon
		Guthion Solupak	azinphosmethyl
		Guthion SC	azinphosmethyl
		Imidan 50 WP	phosmet
		Lagon 480 E	dimethoate
		Lorsban 50 W	chlorpyrifos
		Malathion 25 W	malathion
		Sniper	azinphosmethyl
		Zolone Flo	phosalone
2A[1]	Chlorinated cyclodiene	Endosulfan 50 W	endosulfan
		Thiodan 4 EC	endosulfan
		Thiodan 50 WP	endosulfan
		Thionex 50 WP	endosulfan
3	Diphenylethane	Kelthane 50 W	dicofol
	Pyrethroid	Cymbush 250 EC	cypermethrin
		Decis 5 EC	deltamethrin
		Matador 120 EC	cyhalothrin lambda
		Pounce	permethrin
		Ripcord 400 EC	cypermethrin
4	Chloronicotines	Admire	imidacloprid
		Assail 70 WP	acetimiprid
5	Naturalyte/Spinosyns	Success 480 SC	spinosad
6	Avermectin	Agri-Mek 1.9 EC	abamectin
10	Mite Growth Inhibitor	Apollo SC	clofentezine
11	Bt Microbial	Bioprotec CAF	*Bacillus thuringiensis*
		Dipel 2XDF	*Bacillus thuringiensis*
		Foray 48BA	*Bacillus thuringiensis*
18	Ecdysone disruptor	Confirm 240 F	tebufenizide
19	Triazapentadiene	Mitac W	amitraz
21	Pyridazinone	Pyramite	pyridaben

[1] Other resistance mechanisms that are not linked to site of action, such as enhanced metabolism, are common for this group of chemicals. All members of this class may not have developed significant cross-resistance.

TABLE 4–2. **Fungicide/bactericide groupings based on sites of action**

This list is based on the fungicide listing compiled by the Fungicide Resistance Action Committee (FRAC).

Group	Chemical family or group		Product Name	Active ingredient (*Italicized* indicates the A.I. that puts it in this group.)
1	MBC	benzimidazole	Mertec SC	thiabendazole
		thiophanate	Senator 70 WP	thiophanate-methyl
2	Dicarboximide		Ronilan EG	vinclozolin
			Rovral WP	iprodione
3	DMI	piperazine	Funginex 190 EC	triforine
		triazoles	Indar 75 WP	fenbuconazole
			Nova 40 W	myclobutanil
			Nustar	flusilazole
			Topas 250 E	propiconazole
4	Phenyl Amide (PA)		Ridomil Gold MZ	*metalaxyl* + mancozeb
			Ridomil Gold 480 EC	metalaxyl
7	Anilide carboxamide		Lance WDG	boscalid
9	Anilinopyrimidine		Vangard 75 WG	cyprodinil
11	QoI*	methoxy-carbamate	Cabrio EG	pyraclostrobin
	*sometimes referred to as stobilurins	oximino acetates	Flint 50 WG	trifloxystrobin
			Sovran	kresoxim-methyl
14	Chlorophenyl		Botran 75 W	dicloran
17	Hydroxyaniline		Elevate 50 WDG	fenhexamid
22	Benzamides		Gavel 75 DF	mancozeb + *zoxamide*
33	Phosphonate		Aliette	fosetyl-Al
M	Inorganic		Copper 53W	tri-basic copper sulphate
			Kumulus DF	sulphur
			Lime Sulphur	lime sulphur
			Microscopic sulphur	sulphur
M	Dithiocarbamate		Dikar	*mancozeb* + karathane
			Dithane DG	mancozeb
			Dithane M45	mancozeb
			Ferbam WDG	ferbam
			Gavel 75 DF	*mancozeb* + zoxamide
			Manzate DF	mancozeb
			Penncozeb 75DF	mancozeb
			Polyram DF	metiram
			Ridomil Gold MZ	metalaxyl + *mancozeb*
			Thiram	thiram
M	Phthalimide		Captan 80 WDG	captan
			Folpan 50 WP	folpet
			Maestro 80DF	captan
M	Chloronitrile		Bravo 500	chlorothalonil
M	Guanidines		Equal 65WP	dodine

M = Multisite Inhibitors

2. **After infection activity**: The fungicide penetrates infected tissue and slows or stops fungal growth. This activity is greatest with excellent coverage when applied within 48 hours from start of the wetting period.
3. **Antisporulant activity**: The fungicide penetrates infected blossom tissue and greatly reduces, but does not totally prevent, production of brown rot spores.

Field experience shows that Rovral performs best and is most effective when applied as a protectant prior to an expected wetting per infection period.

- Use Rovral primarily as a protectant fungicide without relying upon its after-infection and antisporulant activities.
- Do not apply more than once during bloom period and not more than once during preharvest period.
- Do not use Rovral more than twice per season, to avoid rapid development of resistance.

Ronilan

As Ronilan is in the same chemical family as Rovral, resistance management practices for Rovral also apply to Ronilan.

Miticides

Kelthane

European red mite (ERM) resistance to this pesticide is widespread in Ontario orchards. A 1992 survey showed that 84% of ERM populations tested in Ontario apple orchards had some level of resistance to Kelthane. Mite pressure, and the use of Kelthane, has increased in peach, nectarine and plum orchards. Many of these blocks now contain populations of European red mite populations that are either resistant or have mixed resistance to Kelthane. In grape vineyards, where Kelthane is often applied 2–3 times, it does a partial or poor job controlling European red mite. In strawberries, two-spotted spider mite populations have also demonstrated resistance to Kelthane.

Resistance to Kelthane is not stable and if not used for 3–5 years the mite population gradually loses its resistance. However, if the chemical is used repeatedly (in 1 season or year-after-year) resistance returns quite quickly.

Apollo

Mite resistance to Apollo has now been found in a few Ontario apple orchards in southern Ontario. It is believed this resistance is not widespread. Resistance has occurred where Apollo has been applied repeatedly in one season, or applied too late in the season, causing season-long selection pressure on mite populations and poor control. Therefore, it is important to follow these recommendations.

- Do not use Apollo every year.
- Only use Apollo once in the season of use.
- Apply Apollo at the prescribed early timing of calyx to 2 weeks after calyx, when mite populations are synchronous and in the first summer generation egg stage.
- Follow a similar strategy of early season use on peaches and nectarines to control mites.

Nematodes

Plant parasitic nematodes can cause significant yield losses to many horticultural crops. The extent of loss depends on the crop, nematode species and soil population level. The most common nematodes in Ontario crops are root lesion (*Pratylenchus*) and root knot (*Meloidogyne*). The pin (*Paratylenchus* sp.), dagger (*Xiphinema* sp.) bulb and stem (*Ditylenchus*), and cyst (*Heterodera* sp.) nematode occasionally cause yield losses to some crops in isolated fields. The dagger nematode is mainly a virus vector on grape, raspberry and apple.

In Ontario, the root-lesion nematode is the most important plant parasitic nematode in fruit crops. Root-lesion nematodes have a wide host range, including many weeds. Nematode populations above economic thresholds can significantly reduce yields (Table 4–3, *Thresholds for nematodes on fruit crops*, on page 49). Damage caused by root-lesion nematodes also provides infection sites for disease causing fungi, which further reduce yields.

- Nematode problems are most often found in sandy loam and sandy soils. Always sample these soils for nematode populations before planting fruit crops.
- Nematode problems are not usually found in clay or clay loam soils. Sample these soils for nematodes before planting in replant sites, or where susceptible crops have been recently grown.

TABLE 4-3. Thresholds for nematodes on fruit crops

Type of nematode	Control when levels reach
Root lesion nematode	1,000/kg soil (exception: 500/kg soil on strawberries)
Root knot	1,000/kg soil
Pin	5,000/kg soil
Dagger	100/kg soil
Bulb and stem	100/kg soil

- Also sample clay or clay-loam soils for dagger nematode on virus-susceptible grapes, raspberry or tree fruit, and for pin nematode on rhubarb, rose and gladiolus.

Information on how to sample soil for nematodes, and where to send the samples is found in Appendix E, *Diagnostic Service*, on page 235.

Nematodes in berry crops

Root-lesion nematode damage on strawberries causes discolouration of the fine feeder roots and tiny, brown, scratch-like lesions on the young white roots. These lesions merge to form large brown areas. Root-lesion nematodes are involved in black root-rot and they aggravate verticillium wilt of strawberries. Severely infected plants are stunted and unthrifty.

Root-lesion nematode feeding on raspberry roots causes scratch-like lesions, similar to the symptoms on strawberry roots. Severely infested plants have thinner and fewer canes per crown. Up to 25% of the first year canes may be killed by severe infestations of these nematodes.

Nematodes in tree fruits

Root-lesion nematodes can be a major cause of orchard replant failures. They can cause a decline in vigour of existing peach and cherry orchards. These nematodes kill the fine feeder roots, causing small brown lesions on the white lateral roots. When lesions merge, the entire root system appears discoloured. Severely affected trees may not have any feeder roots; young replant trees may die. Existing trees lack uniformity.

Nematode control

Use a combination of the following methods to manage nematodes:

- rotate susceptible crops with non-host crops for several years
- plant nematode-suppressing cover crops
- incorporate nitrogenous soil amendments
- destroy residual crop roots
- plant resistant fruit cultivars
- control weeds
- use soil fumigation when necessary.

Examples of nematode-suppressing cover crops:

- oilseed radish
- certain mustards
- specific sorghum x sudan-grass hybrids
- African marigolds
- Canadian Forage Pearl Millet 101.

These cover crops can reduce plant parasitic nematode populations. Not all cultivars reduce nematode populations, so choose the right variety. One or more years of nematode-suppressing cover crops may be required to successfully reduce nematodes below economic thresholds.

Cover crops suppress nematodes in different ways.

- Canadian Forage Pearl Millet 101 inhibits the ability of nematodes to reproduce in its root system.
- Certain cultivars of African marigolds produce a root exudate that kills nematodes in the soil.
- Nematode-suppressing cultivars of oilseed radish and certain mustards release isothiocyanate into the soil that is toxic to the plant parasitic nematode. To be effective, these crops must be cut green and immediately incorporated into the soil.
- Exclude cover crops such as clovers and buckwheat from berry and orchard rotations. These are excellent hosts for root-lesion nematodes. If a cereal grain is to be used for one whole growing season, wheat or barley is the best choice. See Table 3–10, *Characteristics of green manure crops and cover crops grown in Ontario*, on page 39 for more information.

Nematode populations can build on many weed species. A good weed control program is essential the year before planting fruit crops. Weeds should also be controlled when nematode suppressing cover crops are grown.

Keeping land fallow the year before planting also reduces nematode numbers. A disadvantage to fallow land is increased susceptibility to soil erosion.

In orchards, choose ground covers between the rows that do not support nematodes, such as annual or perennial ryegrass.

Preplant soil fumigation is the most effective method of controlling nematode problems. Fumigants can be broadcast over the whole field or applied only in rows where trees will be planted. Tree-row application (treating a 2–2.5 m strip centered on the row) is more economical.

Treat areas that harbour potential nematode problems before planting. Refer to Table 4–4, *Control of nematodes and related problems in strawberry and raspberry plantings in mineral soils* and Table 4–5, *Control of nematodes and related problems in orchards on mineral soils*.

Application of fumigants

Land preparation is critical to effective fumigant application. See OMAF Factsheet *Land Preparation: A Key to Successful Soil Fumigation*, Order No. 89-177. Preplant fumigation is most effective if you take the following steps.

- Fumigate in the fall when soil temperatures are above 4°C. Warmer temperatures (15°C and over) are preferred for more rapid fumigant dispersal in the soil.
- Remove trash and old root systems. Work the soil to a depth of 25–30 cm and obtain good seedbed condition with regard to tilth and moisture.
- Inject the fumigant about 30–40 cm deep.
- Seal the soil surface by packing or watering immediately after injecting the fumigant.
- Leave soil undisturbed until spring or, with fall planting, at least 1 week after injecting the fumigant. Colder soils (below 15°C) require longer periods from injection to aeration.
- Work the soil and aerate for about a week before planting. For fall planting, work the soil and aerate for 2 weeks before planting.
- Use high-quality planting stock grown preferably in fumigated soil.

TABLE 4–4. Control of nematodes and related problems in strawberry and raspberry plantings in mineral soils

To control	Material	Broadcast[1] (L/ha)
Nematodes only	Telone II	170
	Busan 1020	470
Verticillium & nematodes	Telone C-17	200–380
	Vapam[2]	470–900
	Busan 1020	470–935

[1] Use higher rates for heavier soils, e.g. clay loams.

[2] Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

TABLE 4–5. Control of nematodes and related problems in orchards on mineral soils

To Control	Material	Broadcast[1] (L/ha)
Nematodes only	Telone II	200
	Busan 1020	470
Nematodes, diseases	Telone C-17	280
	Busan 1020	470–935
Nematodes, diseases, weeds	Vapam[2]	470–900
	Busan 1020	470–935

[1] Use higher rates for heavier soils, e.g. clay loams.

[2] Vapam is applied by shank injection or in irrigation water, i.e. chemigation. For the chemigation rate, refer to label.

CAUTION

Telone, Vapam and Busan are toxic. Follow instructions regarding procedures for handling and application.

Always follow manufacturer's directions carefully concerning dosage and methods of use. A suitable respirator and protective clothing, etc., must be worn by the applicator. (See *Risks of pesticide use* on page 3.)

Single tree sites for replacement trees

Vapam: Mix Vapam with water. Prepare the site and apply as a drench in the fall to individual replacement tree locations. For each replacement location, construct a circular basin in the soil — approximately 2 m across. While wearing protective equipment and clothing, add 0.3 L of Vapam to 90 L of water in a drum or tank. When solution is thoroughly agitated or mixed, apply it to each basin. This volume of solution is necessary for adequate penetration of the proposed root zone.

Busan 1020: After removing dead or diseased trees and as much of the root system as possible, make a shallow basin over the planting site. Add Busan 1020 to the stream of water while filling the basin. Use 1 L

Busan 1020/10 m^2 in sufficient water (depending on soil type) to penetrate at least 2 m. For control of oak root fungus, use a basin at least 6 × 6 m. Increase dosage to 2 L Busan 1020/10 m^2 in sufficient water to penetrate to the depth of root system. If water is tanked to the planting site, add Busan 1020 to the water and mix before filling basin.

VYDATE L — postplant treatment

CAUTION
Vydate L is very toxic to humans. See references to *Risks of pesticide use* on page 3 and *Cholinesterase blood tests* on page 3. Follow instructions closely regarding proper procedures for handling and applying.

Non-bearing apples
Root-lesion nematode numbers can be reduced in non-bearing apple orchards, after planting, with oxamyl (Vydate L = 240 g active oxamyl/L). Refer to the product label for rates and precautions.

- Apply a liquid soil-drench soon after planting. Mix the soil drench solution at 1.25 L Vydate/1,000 L water and apply at 3.5–10 L of the solution per tree, in a circle around the base of the tree, to cover the root zone. Apply in warm weather. Vydate is less effective in temperatures below 7°C.
- When leaves have expanded, spray the foliage and repeat in 3–4 weeks. Do not allow spray to drift onto trees in bloom. The foliar spray mix is 4.1–8.2 L Vydate/1,000 L water applied at not over 9.3 L Vydate/ha. Sample the soil for nematodes in early September of the planting year to check on the need for further treatment.
- For established non-bearing apple trees, apply the liquid soil drench early in April when buds are swelling. Apply a foliar spray before tight cluster and after petal fall. Do not re-enter treated orchards for 48 hours.

Root absorption of Vydate L occurs during periods of rapid shoot growth (early spring). Foliar absorption occurs best in young, rapidly expanding foliage.

Vydate L does not control soil-borne disease. Vydate L is less effective than preplant soil fumigation. Foliar sprays interfere with insect predators and are not recommended in orchards using integrated pest management.

Raspberries
Use Vydate L to suppress root-lesion nematodes in raspberries. Make 1 application of Vydate L at 9.35 L/ha of treated soil area in the fall as a soil drench over roots. If you are treating a 1.5 m wide strip, use 1.4 L of Vydate L in 360 L of water on 1,000 m of row. Vydate L is absorbed only by raspberry roots that are actively growing. Late application on dormant plants or when air temperature is below 7°C are less effective. Do not apply more than once a year.

Vydate L is highly toxic to bees. Do not apply during the pink or bloom period.

Bird Control

Every year birds destroy large quantities of fruit in Ontario. Sweet cherries, grapes, blueberries and saskatoon berries are the crops most subject to attack, but other fruit crops may also be damaged. Losses for some crops, in some years, are minor compared to total crop loss. The extent of fruit damage varies greatly among cultivars, location and seasons. Pecking and puncturing damage is usually greater than actual losses from fruit consumed and often causes secondary problems with rot.

Controlling bird damage

Fruit becomes attractive to birds as it begins to colour. Start controls early, 10–30 days prior to colouring of the fruit, depending upon the cultivar. An integrated approach is the best method of bird control. Use several control methods to provide a longer lasting effect.

Location

Where you plant commercial fruit crops can be an important factor in controlling birds. Fruit crops planted near a wooded area are particularly susceptible to damage, because birds find shelter and nesting sites close by.

Physical protection

The only effective control method is to cover the crops with netting. This method may be economically feasible for some higher valued cultivars of grapes, cherries and highbush blueberries. There is considerable interest by growers to find simpler, cost-effective netting systems for fruit crops.

Shooting

Normally, shooting does not significantly reduce bird populations, but it does frighten them out of the orchard. Laws protect robins and Northern orioles, but special permits may be obtained to kill them if you can show they are causing damage.

For a permit, contact the enforcement co-ordinator, Canadian Wildlife Service, Environment Canada, 905-336-6410.

Shells are also available with delayed explosions and/or sustained whistles that disorient and frighten the birds.

Propane-fired bird scaring cannons

Cannons are one of the most commonly used bird scaring devices. These devices cause birds to flee by producing loud, unexpected gunshot-like sounds, usually at random intervals. Regular movement of these devices to different locations in the orchard or vineyard is very important. Birds quickly adjust their feeding habits if cannons are left in the same location throughout the harvest season.

A major drawback of these devices is the disruption to neighbours. Growers must recognize this and adjust the use of this equipment to cause the least discomfort to neighbours while protecting their crops.

Electronic sound devices

This equipment sends out electronic sounds that imitate distress or predator calls of different bird species, or other types of sounds. Although they produce a loud sound, it is usually less objectionable to neighbours than propane-fired cannons.

Chemical controls

There are currently no chemicals registered for use in Ontario to control birds in fruit crops. It is illegal to use unregistered chemicals on any crop.

Visual deterrents

Visual deterrents include: aluminum foil hung in trees, model hawks and other birds of prey, strips of yellow plastic hung across vineyards, vibrating plastic strips, scarecrows, mirrors, kites and scare-eye balloons. Visual deterrents move with the wind, producing noise and making reflections.

Falconry

Trained falcons and hawks have been used successfully for many years at airports. Experienced falconers are needed to fly the birds. Availability, cost and time are major drawbacks for fruit growers.

Regardless of the bird control method used, follow all local, provincial and federal laws governing the killing of birds or the use of sound-scaring devices.

Deer and Rodent Control in Orchards

For more information on all aspects of deer and rodent control, see OMAF Factsheet, *Rodent and Deer Control in Orchards,* Order No. 98-023 and Publication 10, *Deer Control Practices in Agriculture.*

Control of rodents and deer is most effective when it is part of a season-long management strategy. This includes good sanitation, cultural and chemical control methods.

Deer control

Deer removal permit program

You must have a permit to shoot deer in defense of property. Contact the local Ministry of Natural Resources (MNR) office for an evaluation and action plan. Action depends on the severity of damage, the level of previous control attempts and a reasonable expectation of controlling the problem deer.

The MNR area supervisor or enforcement supervisor issues permits to farmers or their agents in order to kill white-tail deer in defense of property under Section 2.1 of the *Game and Fish Act*.

Before a deer removal permit is issued, the following conditions must be satisfied.

- Deer damage is evaluated as economically significant by the evaluator. A written report must be filed reflecting the extent (percent of crop) and associated dollar value.

- The farmer permits licensed deer hunters on the property during open season (if any); the farmer has made reasonable attempts to control deer using deterrents or by modifying farm management practices. This should be documented and kept with the deer removal permit file.
- Appropriate arrangements for disposing of the carcass(es) have been made.

Mouse and vole control in orchards

A wide herbicide strip in the tree row or under individual trees, coupled with regular close mowing of orchard ground cover, helps discourage mice.

- Remove straw, trash, sod, etc. from around the base of the tree for at least 60 cm from the trunk. Predation by cats, foxes and birds of prey (especially red-tailed hawks, kestrels and great horned owls) all contribute to a low mouse population.
- Place a guard around the trunk of all newly planted trees. A number of commercial tree guards are available. Two of the most common are spiral plastic and galvanized wire mesh. Bury the bottom of the guard in the soil 5 cm deep, or preferably, in a mound of fine crushed stone or sharp cinders.
- Check tree guards each fall to see they are mouse tight, free of trash and are not interfering with root development.

Bait for mouse and vole control in orchards

Baits are most effective if dropped apples are picked up and removed from the orchard. Before the grass falls over and the ground is covered with snow, broadcast bait over the floor of the orchard. Baits are best applied on bright days with no rain expected for several days.

Several commercial formulations of bait are available for orchard use. Consult the label before applying and obey all safety instructions.

- **Zinc phosphide-treated baits**: Several products are available. Application rates are between 4.5–9 kg/ha, depending on the severity of infestation. If further mouse activity is detected, repeat the treatment when rain is not expected.
- **Diphacinone (Ramik Brown)**: Apply twice, 11 kg/ha, 20–40 days apart. (Total application rate 22 kg/ha.)
- **Chlorophacinone (Rozol, Groundforce)**: Apply 11–11.25 kg/ha and repeat in 20–60 days where infestation is high.

Bait stations help control mice longer than broadcast treatment. Bait stations also help prevent non-target mammals from feeding on the bait. Pieces of board or tin cans with one end removed can be used for bait stations. Place the bait under the board or in the can, with the can lying on its side. The "inverted T" bait station made of 1½ inch ABS pipe is the most effective bait station available. In this station several tablespoons of bait are placed in the neck, then capped, protecting the bait from the elements. Set up bait stations at a rate of approximately 25/ha (10/acre).

Baits are poisonous to humans, domestic animals and wildlife.

- Store the bait away from children, irresponsible persons and animals.
- Wear chemical-resistant gloves and wash after handling poison baits.
- Avoid inhalation of dust or fumes.
- Destroy of empty containers safely. See *Disposal of pesticides and empty pesticide containers* on page 11.
- Keep children, pets and domestic animals away from treated areas.
- Where possible, remove mouse bodies and bury or dispose of them in a safe manner.

Controlling rabbits

Wrapping young trees

Wrap sacking around the top and the trunk above the mouse guard to protect young trees from rabbits. Tie the wrapped tree securely to a strong stake or steel fence post to prevent snow and ice breaking the tree over. Mouse guards generally do not give protection against rabbits when the snow is deep.

Repellents

Rabbits do not like to feed on the trunks of young trees if the trees have been treated with thiram. There are a number of commercial mixtures available, some of which mix white latex paint with thiram. Be sure to treat the tree as high as rabbits can reach when standing on deep snow.

For more information on applying paint with thiram, refer to *Control of southwest injury on fruit trees.*

Repairing damage by mice and rabbits

Carry out regular inspection throughout the winter to check for injury. Mice often work just below the surface of the snow or in the litter. If a tree has been wholly or partially girdled, cover the wound with grafting compound or wound dressing promptly or before drying out occurs.

Before the buds swell in the early spring, secure scions that are long enough to bridge the wound. See OMAF Factsheet *Repair Grafting*, Order No. 98-003. Store scions in damp sand or sawdust in a cool place, or preferably, refrigerated conditions. If the wound extends for more than one quarter of the circumference of the trunk, bridge graft in the manner described in *Repair Grafting*. Graft when the bark slips readily from the wood (about bloom). Repair grafting is not practical on trees with a diameter less than 10 cm. Instead, replace small trees.

Control of Southwest Injury on Fruit Trees

Southwest injury (winter sunscald) occurs during the winter and is especially severe when cold, sunny days are followed by cold, still nights. This phenomenon can occur in apple, peach, pear, cherry, plum and apricot orchards. Injuries are usually confined to the south and southwest sides of the trunks and main scaffold branches. On sunny days these tissues become considerably warmer than the surrounding air and at night they cool rapidly. Under these conditions, freezing of the bark may occur. Freezing injury usually affects large portions of the bark tissue that become brown and eventually slough off as healing occurs beneath.

In stone fruit orchards, these injuries provide ideal sites for infection by peach canker or other canker diseases. The combined effect of southwest injury and peach canker greatly reduces the productive life of affected trees.

Painting the trunk, crotches and lower parts of main scaffold branches with exterior white latex paint can minimize southwest injury. The white paint reduces the damage by reflecting direct sunlight on exposed tissue. This helps to prevent rapid warming on sunny days when air temperatures are below freezing.

Do not use oil-based paints or latex paints that contain some oil. These products contain toxic materials that may injure or kill fruit trees.

- October is the best time to apply the paint. Best results are obtained when trees are painted on days when the temperature is above 10°C and conditions favour rapid drying.
- Apply the paint by brush or by spray. When spraying, use 1–2 L of water/4.5 L of paint, depending on the thickness of the paint and the air pressure available.
- On young trees, paint the whole trunk, but on older trees only the south and southwest sides of the trees require painting. The whiter the bark after painting, the greater the protection. Better quality paints are more durable.
- On young trees, injury from rodents may be a greater problem than southwest injury. To obtain protection from both problems, use commercially available thiram-latex mixtures which reflect sunlight and act as a taste repellent for rodents.
- Do not use the thiram-latex mixture if you plan on using a fall Bordeaux spray program. The thiram reacts with the Bordeaux spray, changing the colour of the paint from white to brown, and reducing its effectiveness as a heat reflector. The Bordeaux spray does not affect trees painted with latex only and can be used when thiram is excluded from the mixture.

Use of Copper Products on Fruit Crops

Chemical characteristics of copper fungicides

Copper mixtures have long been recognized as having fungicidal properties. Historically, Bordeaux mixture was an important copper fungicide. It was made by mixing bluestone (a raw form of copper sulfate) and hydrated lime.

Free copper ions provide most of the activity that copper mixtures have on fungal and bacterial diseases. This free copper can also be toxic to plants, causing burning of leaves, and burning or scarring of fruit. Bordeaux mixtures are considered unsafe after "1/4 inch green" on most fruit crops.

"Fixed copper" collectively describes a group of copper formulations containing complex copper sulfates, copper oxychlorides, and copper oxides. Fixed copper compounds are:

- easier to handle than Bordeaux
- equal in effectiveness to Bordeaux, except they do not adhere or persist as well
- generally less phytotoxic and less corrosive than Bordeaux.

These new copper formulations have a small particle size and have added materials to improve spreading and sticking qualities. Check the product label for use patterns and timings for each crop.

Procedures to tank-mix copper formulations and lime

Some fixed copper labels suggest mixing the copper with lime. If you have problems mixing fixed coppers with lime, follow these instructions:

1. Start water flowing into the spray tank.
2. When the tank is about 1/3rd full and the mechanical agitator is operating, start washing the powdered copper product into the tank through a screen with water from the supply hose. Use a wooden spoon to help work the copper product through the screen. The screen prevents large granules of copper (especially if opened product gets wet, then dries) from getting into the tank. Premixing the copper product with hot water also helps the product dissolve. Put all of the copper in the tank by the time the tank is 2/3rd full.
3. Wash the lime mixture through the screen into the copper solution in the tank.Use hydrated or builder's lime. Presoaking the lime before adding to the copper solution in the tank may be preferable to washing powdered lime directly through the screen into the tank. Use lots of water from the supply hose to dilute the lime as much as possible before it meets the copper solution.
4. Keep the agitator running continuously and apply the copper mixture immediately. Do not allow the mixture to settle out.

Registration status and availability of copper fungicide products

It is important to use only copper products that have a federal label with a PCP number. The PCP number indicates a product approved as a crop protection product for application on agricultural crops. Presently, there are 5 copper products with PCP numbers and a federal registration. For a summary of labelled products and crop uses consult Table 4–6, *Copper products for use on fruit crops in Ontario.*

TABLE 4–6. Copper products for use on fruit crops in Ontario*

Category	**Registered Copper Products**				
Product Name	**Copper 53W**	**Griffin Basicop**	**Guardsman Copper Oxychloride 50**	**Copper Spray**	**Triangular Brand Copper Sulfate**
PCP Registration No.	**09934**	**19003**	**13245**	**19146**	**24034**
Ontario Classification	**Schedule 2**	**Schedule 3**	**Schedule 2**	**Schedule 3**	**Schedule 3**
Active Ingredient	**Copper from tribasic copper sulfate 53%**	**Copper in basic copper sulfate 53% by weight**	**Copper from copper oxychloride 50%**	**Copper from copper oxychloride 50%**	**Cupric sulphate pentahydrate (metallic copper 25.2%)**
APPLES					
registration status	✓	✓	✗	✓	✓
rate of formulated copper^{1}	1 kg	1 kg		4 kg	2 kg
rate of hydrated lime	6 kg	6 kg		—	6 kg
APRICOTS					
registration status	✗	✗	✗	✗	✗
rate of formulated copper^{1}					
rate of hydrated lime					
BLACKBERRIES					
registration status	✗	✗	✗	✗	✗
rate of formulated copper^{1}					
rate of hydrated lime					
BLUEBERRIES (highbush)					
registration status	✗	✗	✓	✓	✗
rate of formulated copper^{1}			2–4 kg	2–4 kg	
rate of hydrated lime			no lime required	no lime required	
CURRANTS					
registration status	✓	✓	✗	✗	✗
rate of formulated copper^{1}	3–5 kg	3–5.5 kg			
rate of hydrated lime	4 kg	4 kg			
FILBERTS HAZELNUTS					
registration status	✗	✗	✓	✓	✗
rate of formulated copper			3–9 kg/ha	3–9 kg/ha	
rate of hydrated lime			no lime required	no lime required	
GOOSEBERRIES					
registration status	✓	✓	✗	✗	✗
rate of formulated copper^{1}	3–5 kg	3–5.5 kg			
rate of hydrated lime	4 kg	4 kg			
GRAPES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper^{1}	3 kg^{2}	3 kg	3 kg^{3}	3 kg^{3}	
rate of hydrated lime	6 kg	6 kg	6 kg	6 kg	
PEACHES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper^{1}	4 kg	4 kg	2kg	2 kg	
rate of hydrated lime	no lime required	no lime required	no lime required	no lime required	

* (List of copper products with federal registration and classified for sale and use in Ontario, as of November, 2003)

[1] Rate is expressed kg/1,000 L of water unless otherwise stated. To calculate rate per ha see Table 2–2, *Water volume guidelines based on tree row volume*, on page 22 and *Pesticide Application* on page 17. Also check label for maximum rate per hectare.

[2] Do not use on French hybrids or vinifera varieties.

[3] Do not use on Seibel varieties.

✓ registered in Ontario

✗ not registered

TABLE 4-6. Copper products for use on fruit crops in Ontario* (Continued)

Category	Registered Copper Products				
Product Name	**Copper 53W**	**Griffin Basicop**	**Guardsman Copper Oxychloride 50**	**Copper Spray**	**Triangular Brand Copper Sulfate**
PCP Registration No.	**09934**	**19003**	**13245**	**19146**	**24034**
Ontario Classification	**Schedule 2**	**Schedule 3**	**Schedule 2**	**Schedule 3**	**Schedule 3**
Active Ingredient	**Copper from tribasic copper sulfate 53%**	**Copper in basic copper sulfate 53% by weight**	**Copper from copper oxychloride 50%**	**Copper from copper oxychloride 50%**	**Cupric sulphate pentahydrate (metallic copper 25.2%)**
PEARS					
registration status	✓	✓	✗	✗	✓
rate of formulated copper[1]	1 kg	1 kg			2 kg
rate of hydrated lime	6 kg	6 kg			6 kg
PLUMS					
registration status	✗	✗	✗	✗	✗
rate of formulated copper[1]					
rate of hydrated lime					
RASPBERRIES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper	4–5 kg/ha	4–5 kg/ha	2.5–3.0 kg/ha	2.5 kg/ha	
rate of hydrated lime	no lime required	no lime required	no lime required	no lime required	
SOUR CHERRIES					
registration status	✓	✓	✓	✓	✗
rate of formulated copper[1]	2 kg	2 kg	2 kg	2 kg	
rate of hydrated lime	4 kg	no lime required	4 kg	4 kg	
SWEET CHERRIES					
registration status	✗	✗	✗	✗	✗
rate of formulated copper[1]					
rate of hydrated lime					
STRAWBERRIES					
registration status	✓	✓	✗	✗	✗
rate of formulated copper	2.5–3.8 kg / ha	2.3–3.8 kg/ ha			
rate of hydrated lime	no lime required	no lime required			
WALNUTS					
registration status	✗	✗	✗	✓	✗
rate of formulated copper				4 kg/ha	
rate of hydrated lime				no lime required	

* (List of copper products with federal registration and classified for sale and use in Ontario, as of November, 2003)

[1] Rate is expressed kg/1,000 L of water unless otherwise stated. To calculate rate per ha see Table 2-2, *Water volume guidelines based on tree row volume*, on page 22 and *Pesticide Application* on page 17. Also check label for maximum rate per hectare.

[2] Do not use on French hybrids or vinifera varieties.

[3] Do not use on Seibel varieties.

✓ registered in Ontario

✗ not registered

5. Food Safety

On-Farm Food Safety for Fruit and Vegetable Growers

Food safety hazards include biological, physical or chemical substances that can cause fruit and vegetables to become an unacceptable health risk to consumers.

- **Biological hazards**: Micro-organisms such as bacteria, viruses, parasites, moulds.
- **Physical hazards**: Foreign objects (i.e., wood, plastic, glass) from the environment or equipment.
- **Chemical hazards**: Pesticides or other contaminants.

Contamination of produce can occur directly or indirectly. Produce may be directly contaminated by food safety hazards at the farm or indirectly through contaminated soil, water, etc. Minimize the risk of contamination by:

- being aware of the hazards
- identifying potential sources of contamination and using best management practices to minimize risks
- periodically reviewing all farm practices with food safety in mind.

Many growers use the good agricultural practices presented below. Good record keeping of on-farm practices that relate to food safety is useful in today's marketplace.

Preventing biological hazards on fruit and vegetables

Sources of contamination

- Untreated or raw manure used for fertilizing.
- Produce that comes in contact with contaminated soil, water or feces from animals (e.g., rodents, birds, domestic animals and wildlife).
- Containers and/or equipment not cleaned adequately.
- Handling of produce by infectious workers.

Good agricultural practices

- Know the history of your land. Fields where livestock or wild animals have grazed, or where biosolids or sludge have been applied, are more likely to have pathogenic bacteria.
- Take measures to discourage roosting of birds above packing, handling and storage areas.
- Maximize the period between when manure is applied and when the crop is harvested. Incorporate manure into the soil before planting. Do not apply manure after planting where direct or indirect contact may occur with the edible part of the crop. (See *Food safety concerns with manure application and timing* on page 33.)
- Use properly composted manure to reduce the risk of potential food borne illness. Proper composting includes temperature monitoring, and ensuring all parts of the pile are allowed to heat up to temperatures that are lethal to microbes. For information on composting, refer to resources listed, under crops-organic, on the OMAF web site *www.omaf.gov.on.ca*.
- If manure is not composted, reduce the risk of pathogen contamination by allowing the manure to age for at least 6 months, preferably 1 year prior to application.
- Do not use manure for side-dressing.
- If stockpiling manure on the farm, do not locate manure piles near crops or harvested produce that could be contaminated by wind-blown debris from the pile.
- Do not locate manure piles where run-off could potentially contaminate water sources.
- Clean and sanitize farm implements to prevent cross-contamination.

- Make sure water quality is appropriate for the use. Use potable water for hand washing, cleaning surfaces, etc.
- Consider testing irrigation water for bacterial levels. The frequency of tests taken per year depends on the type of water source and what it will be used for. Ditch or surface water requires more testing than well or municipal water.
- Depending on water source, consider installing drip irrigation rather than overhead sprinklers to reduce the risk of contamination, especially for produce generally eaten uncooked.
- Cool fruits and vegetables quickly to maintain quality. Keep coolers and storage areas clean and ensure cooling equipment is maintained and sanitized.
- Ensure toilets and hand-washing stations are stocked and cleaned regularly, and are accessible to staff and visitors.
- Teach workers the importance of personal hygiene practices and establish training guidelines.

Preventing physical hazards on fruits and vegetables

Sources of contamination

- Dirty harvesting and packing equipment.
- Broken lights or bottles.
- Damaged containers or pallets.
- Inadequate cleaning after repairs or maintenance.
- Equipment parts or metal staples from packing equipment.
- Improper grading or inspection of finished product.
- Careless or untrained staff.
- Inappropriate clothing and jewellery.

Good agricultural practices

- Construct and maintain structures to minimize risk of contamination.
- Maintain equipment regularly, and ensure equipment is cleaned and ready for use after repairs or maintenance.
- Teach workers about physical hazards and ensure they follow all existing guidelines.

Preventing chemical hazards of fruits and vegetables

Sources of contamination

- Pesticide residue in soil from previous use.
- Pesticide not registered/approved.
- Incorrect mixing/concentration higher than recommended rate.
- Days-to-harvest period not followed.
- Dumping, accidental spillage or seepage of pesticide into soil or water source.
- Equipment either not, or incorrectly, calibrated.
- Equipment not cleaned after use.
- Pesticide residue in picking bin or crate.

Good agricultural practices

- Know the history of the land. Chemicals, biosolids or sludge may have been used previously and possible residues left behind.
- Use pesticides as directed on the label. Ensure they are safely stored and labelled in a secure area.
- Participate in the Grower Pesticide Safety program. Ensure employees who handle pesticides are also certified.
- Consider doing a yearly chemical residue test of your product to verify that chemicals are applied correctly.
- Calibrate your sprayer regularly.

References

Ontario Ministry of Agriculture and Food
www.omaf.gov.on.ca

Canadian Water Quality Guidelines for Agricultural Water
http://www.ccme.ca/assets/pdf/e1_06.pdf

Canadian Hort Council Guidelines
www.hortcouncil.ca/offs.htm

Canadian Food Inspection Agency:
Traceback Investigation Guidelines for Fresh Fruit & Vegetables
http://www.inspection.gc.ca/english/plaveg/fresh/traretinvenge.shtml

Code of Practice for Production and Distribution of Unpasteurized Apple and Other Fruit Juice/Cider in Canada
http://www.inspection.gc.ca/english/plaveg/protra/codee.shtml

Guide to Minimize Microbial Food Safety Hazards for Fresh Fruits and Vegetables
www.foodsafety.gov/~dms/prodguid.html

Good Agricultural Practices for Fresh Fruits and Vegetables
www.hort.cornell.edu/extension/commercial/vegetables/issues/foodsafe/index.html

National Food Safety Database
www.foodsafety.gov

Food Safety Network
www.foodsafetynetwork.ca/

6. Pollination and Bee Poisoning Prevention

Pollination Requirements for Fruit Crops

Most fruit crops benefit from or require insect pollination.

Apples

Apple cultivars grown in Ontario do not generally set fruit with their own pollen. Pollination with pollen from more than 1 cultivar normally results in larger fruit compared to fruit grown from a single source of pollen. A bloom requires 8–24 visits by pollinators. A well-designed orchard reduces the number of bee visits required.

Good pollen movement is necessary for fruit with high seed count. Good pollen movement in a higher density planting is generally limited to 3–4 rows across the orchard. The distance pollen travels down the row is limited to a few trees. For this reason, 2 or more compatible cultivars must be planted together in the orchard to allow for cross-pollination and fruitfulness. Varying the placement of beehives does not normally have a significant influence on pollen dispersal distances within the apple orchard.

Apricots

Most varieties are self-fruitful and may be planted in solid blocks. Because apricots bloom early when the weather is unreliable, provide honeybees to help with pollen transfer.

Blueberries

Blueberries are self-fruitful and may be planted in solid blocks. However, cross-pollination of cultivated blueberries can give larger berries, higher yields and somewhat earlier ripening. It is advisable to plant more than 1 blueberry variety. Honeybees help with pollination.

Sour cherries

Sour cherries are self-fruitful and do not require pollenizer cultivars for a commercial crop. For maximum production of sour cherries, use honeybees at a rate of 2 strong hives per hectare. Sour cherries and sweet cherries are different species and will not pollinate each other.

Sweet cherries

Sweet cherries are not pollinated by wind; the honeybee is the only effective pollinating insect reported. Use 2 hives per hectare. Many sweet cherry cultivars are self-unfruitful and must not be planted in solid blocks. Certain groups of cultivars will not pollinate each other. Careful attention to planting arrangement of sweet cherries is required. Recent sweet cherry cultivar introductions from the Vineland breeding program are self-compatible and do not require cross pollination.

Currants and gooseberries

These are self-fruitful, but insects assist in pollen transfer. Honeybees can increase crop yield.

Grapes

All commercial varieties of grapes are self-fruitful and are pollinated by wind. It is not necessary to provide honeybees for pollination.

Peaches and nectarines

All commercial varieties grown in Ontario are self-fruitful and may be planted in solid blocks. Honeybees readily work peach blossoms and frequently cause a heavy set, resulting in extra thinning costs. For this reason, do not put beehives in peach orchards.

Pears

All varieties in Ontario are self-unfruitful. Mixed plantings are necessary. Insects are required for cross-pollination. Honeybees do not find pear blossoms as attractive as most other fruit. Careful timing of the introduction of honeybees to orchards is necessary. Place up to 8 strong hives per hectare when the orchard is about 25% in bloom. Use pollen inserts to help overcome pollination problems.

Plums

Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.

Raspberries and blackberries

Raspberries and blackberries are self-fruitful. Their bloom is very attractive to bees.

Strawberries

Strawberries are self-fruitful, and are pollinated by gravity, wind and insect transfer. Pollination by honeybees or other insect pollinators may improve berry size and shape.

Tree nut crops

These rely on cross pollination achieved mainly by wind action.

Using Honeybees Effectively

The primary domesticated insect pollinator of cultivated crops is the honeybee. Many growers facilitate the pollination process by arranging to have beekeepers move honeybee colonies into their crops during the blooming period. The following information will help you use honeybees more efficiently.

- Obtain honeybees from a reliable beekeeper able to supply strong, healthy colonies. Weak colonies are of little value for early spring pollination when cool weather is often encountered.
- Two to 3 colonies of honeybees per hectare provide satisfactory pollination. Stocking rates vary depending on the type of fruit, the variety and the planting density. In young orchards fewer honeybee colonies may be required because there are generally fewer blossoms to pollinate. On the other hand, for early blooming fruit crops such as apricots, cherries and plums, use more honeybee colonies than the recommended stocking rates indicate. This precaution should compensate for the negative effect of cold weather, which often occurs during the pollination period of these crops.
- A pollen insert is a device that forces bees leaving the hive to crawl through a shallow tray containing pollen from the desired pollenizer. Pollen adheres to the legs and body of each foraging bee to enable it to cross-pollinate the blossoms it visits.
- When using a pollen insert, place hives in the crop after blossoms have partially opened (earlier for sweet cherries, later for pears). This encourages more bees to work the fruit blossoms in the immediate surroundings, rather than foraging elsewhere. Have 5 colonies per hectare when using pollen inserts.
- Weather is often cool during the pollination period for early-blooming fruit crops. To encourage maximum honeybee flight during cool weather, protect the colonies from cold spring winds. Place the colonies in larger groupings in sunny, sheltered locations. Where there is no natural windbreak, erect a temporary wind shelter using, for example, bales of straw. Place the colonies so that the morning sunshine strikes the hive entrances.
- Provide water to colonies during bloom periods that are exceptionally dry. Bees will abandon pollen collection in favour of securing water for the colony. A shallow tub of water with floating sticks allows bees to land without drowning.
- Honeybees favour apple pollen over dandelion pollen. Apple pollen provides a higher quality protein that bees require to feed colony brood. Although bees will forage on dandelion as a protein source, the vast majority will move to apple pollen quickly when it becomes available. Apple growers should not be concerned about dandelion bloom drawing bees away from apple bloom.

Bee Poisoning

Bees are essential for the pollination of most tree and small fruits. Insecticides, many of which kill bees, are required for insect control. With careful management, you can obtain both pollination and insect control. You can protect the bees by following these suggestions.

- Before you apply a pesticide, advise local beekeepers so that they can move colonies out of the danger area. For a list of provincial bee inspectors, see *www.omaf.gov.on.ca* or contact the provincial apiarist at 1-888-466-2372 ext. 63595, for a list of the beekeepers in your area.
- Do not apply insecticides while fruit trees are in bloom. The *Bees Act* makes it an offence to do so in Ontario. Read the pesticide label for guidelines.
- Do not spray any flowering crop on which bees are foraging. Time of treatment is important. In general, daytime treatments when bees are foraging in

the field are most hazardous. Insecticide applications in the evening are the safest. Early morning is the next best time. Bees usually do not forage at temperatures below 13°C.

- Remove honeybee colonies as soon as pollination is complete and before any postbloom insecticides are applied.
- If there is a risk of honeybee poisoning, try to choose an insecticide that is not highly toxic to the bees. When there is a choice, choose the product formulation that is less hazardous to bees. EC formulations are less toxic than WP formulations.
- Honeybees frequently are poisoned by visiting cover crops, such as dandelions or clovers, that are in bloom in the orchard or field. Clipping or beating down such crops prior to spraying will help safeguard the bees.
- Do not apply insecticide on windy days to prevent drift toward any nearby hives.

The following groups found in Table 6-1, *Relative toxicity of pesticides to honeybees*, (products used on fruit crops) show the relative toxicity of pesticides to honeybees as determined by laboratory and field tests.

For more detailed information on the toxicity of specific pesticides to honeybees refer to the pesticide label.

TABLE 6–1. Relative toxicity of pesticides to honeybees

Group I: **Pesticides highly toxic to bees**	**Group II:** **Pesticides moderately toxic to bees**	**Group III:** **Pesticides relatively non-toxic to bees**
Severe losses may be expected if the following materials are used when bees are present at treatment time or within a few days thereafter.	These can be used around bees if dosage, timing, and method of application are correct, but do not apply them directly on bees, in the field or at the colonies.	
Admire Agri-Mek 1.9EC Cygon 480–Ag Cymbush 250 EC Decis 5EC Diazinon 500 E Diazinon 50W Furadan 480F Guthion Solupak Guthion SC Imidan 50 WP Lagon 480E Lorsban 50W Malathion 25W Matador 120EC Pounce Pyramite Ripcord 400EC Sevin XLR Plus Success 480 SC Sniper Vydate L	Assail 70 WP Carzol SP Dikar Endosulfan 50W Lannate Nustar Pirimor 50DF Thiodan 4EC Thiodan 50WP Thionex 50 WP Zolone Flo	Aliette WDG Apollo SC Bioprotec CAF Botran 75W Bravo 500 Cabrio EG Supra Captan 80 WDG Confirm 240F Copper 53W Copper Spray Dipel 2X DF Dithane DG Elevate 50 WDG Equal 65 WP Ferbam 76 WDG Flint 50WG Folpan 50WP Foray 48BA Funginex 190 EC Gavel 75 DF Indar 75 WSP Kelthane 50W Kumulus DF Lance WDG Maestro 80 DF Manzate 200 DF Manzate 200 WP Mitac W Nova 40W Penncozeb 75DF Polyram DF Ridomil Gold 480 EC Ridomil Gold MZ Ronilan EG Rovral Senator 70WP Sovran Streptomycin 17 Topas 250E Vangard 75WG

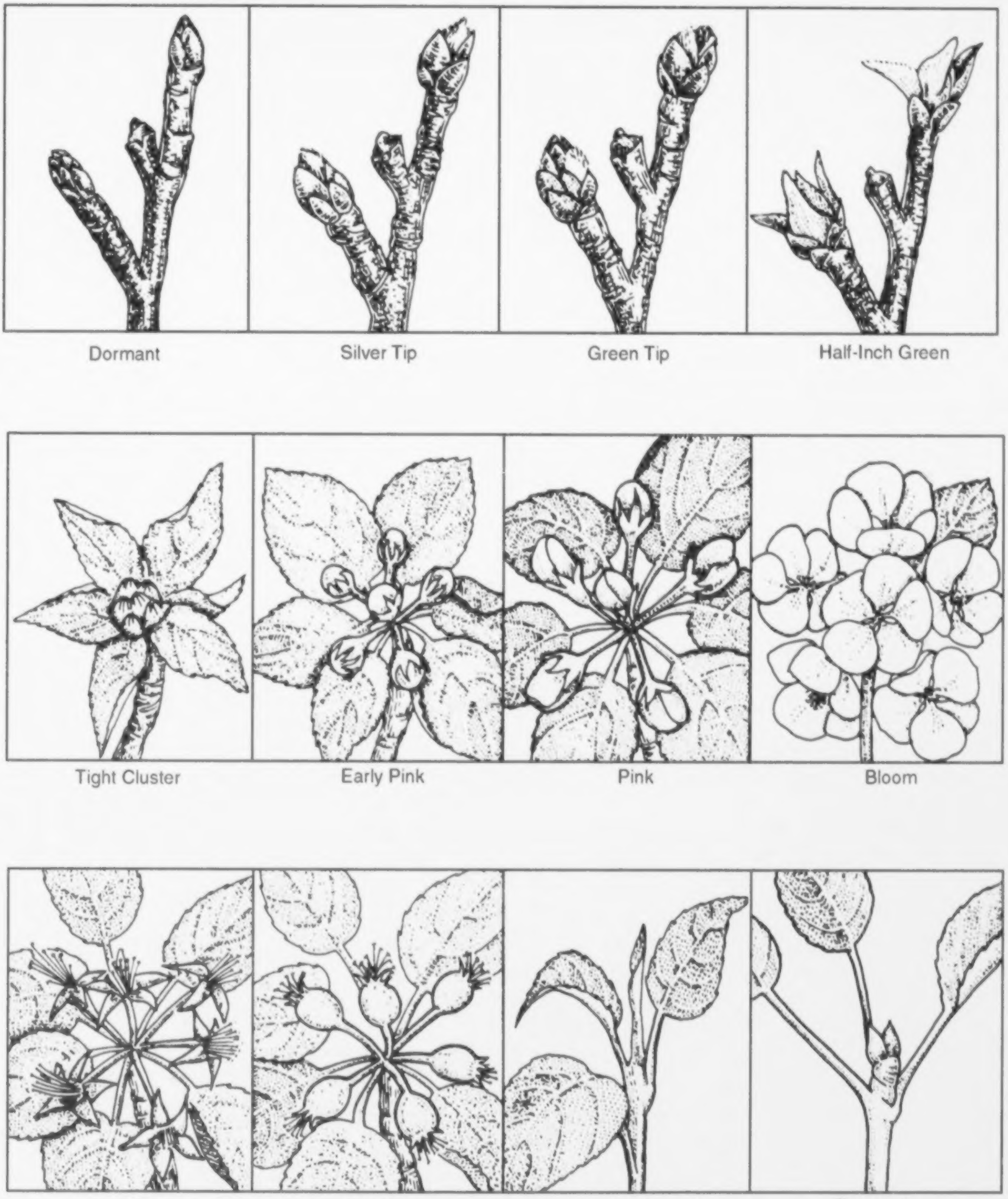
EXTREMELY TOXIC TO BEES

FURADAN 480F

This insecticide has caused more loss and confirmed cases of poisoning to bees in Ontario than any other of the materials mentioned in this publication. Fruit growers and apiarists require close liaison when and where Furadan is used.

7. Apples

FIGURE 7–1. Apple growth stages



Dormant
Silver Tip
Green Tip
Half-Inch Green
Tight Cluster
Early Pink
Pink
Bloom
Petal Fall
Fruit Set
Terminal Growth
Regrowth

APPLE NUTRITION

It is important to test and prepare soil before planting trees. To ensure long-term productivity of this perennial crop, prepare the soil by tilling and adding organic matter well ahead of planting. For information on building and maintaining soil-organic matter see sections *Managing Organic Nutrient Additions* on page 30 and *Manure for Orchards*, below.

Prior to planting, ensure nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. Refer to Table 7–2, *Phosphorus and potassium soil requirements before planting apples*, on page 69. Phosphorus, potassium and lime are not readily leached through the soil and preplant applications are the most effective.

Manure for Orchards

Animal manure contains varying levels of nutrients and organic matter. The disadvantage of adding manure to orchards is that the nitrogen is mineralized over time. This slow release means that the orchard continues to receive nitrogen throughout the year. Excessive nitrogen can result in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue. This makes trees more susceptible to winter injury.

- Do not put manure around newly planted trees because of potential winter injury problems. If manure is used, broadcast at moderate rates and work into the soil in late fall or early spring before planting.
- Apply no more than 7 t/ha of poultry manure (20 m^3 liquid), 40 t/ha of cattle manure (100 m^3 liquid) and 35 t/ha hog manure (65 m^3 liquid). Since the nutrient content of manure varies greatly, conduct nutrient analysis before applying. See *Manure analysis* on page 32 for more details.
- When using manure, reduce the rate of nitrogen, phosphorus and potassium fertilizers applied. Table 3–5, *Average amounts of available nutrients for different types of manure*, on page 31 shows the average composition of some manures and suggested reduction of fertilizer when manure is used.
- For more information about food safety and environmental impacts when applying manure, refer to *Environmental concerns with manure* on page 32 and *Food safety concerns with manure application and timing* on page 33.

pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, it can affect nutrient uptake and crop performance. To determine pH, take a soil sample. For information on soil sampling, see *Soil Testing* on page 25.

- Always take a soil sample before establishing a new planting. In a new orchard the target pH is 6.5 on sandy soils and 6.0 on clay soils.
- If lime is required, incorporate it during soil preparation.
- In established orchards, sample soil in the tree row every 3 years to be sure the pH is satisfactory. If pH is low (acidic), apply lime to the sod cover in the fall or before spring cultivation. The results do not show immediately because lime reacts slowly into the soil.
- In established orchards apply lime when the pH on clay loam soils drops below 5.1 and on sandy soils below 5.6. This will raise the soil pH, reducing the acidity and also supply calcium.
- On soils low in magnesium use dolomitic lime, which is high in magnesium.
- Application rates vary with soil type and initial pH. The buffer pH indicates the rate of lime to apply. For information on lime, refer to *Soil Acidity and Liming* on page 28.

Leaf Analysis

In established plantings leaf analysis is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the tree's uptake of nutrients. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests see *Plant Analysis* on page 26.

TABLE 7–1. Nutrient level range (% dry weight) of mid-shoot leaves (taken last 2 weeks of July from mature trees)

	Nitrogen* (N)		Potassium (K)		Magnesium (Mg)
Leaf analysis	**Low if below**	**High if above**	**Low if below**	**High if above**	**Low if below**
APPLE					
Delicious, Crispin	2.2	2.7	1.4	2.2	0.25
Empire, Spy	2.1	2.6	1.3	2.1	0.25
McIntosh, others	2.0	2.5	1.2	2.0	0.25

* Leaf nitrogen in non-bearing trees should be 0.2% higher.
Apple trees on M.9 or M.26 rootstocks should be 0.2% higher.

Nutrient uptake is affected by many orchard conditions. Consequently, each year nutrient levels vary slightly depending on the season. To obtain optimum growth and fruit quality, adequate levels of all nutrients must be present — and balanced — in the leaves.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAF Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91-012.

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. Consult Table 7–1, *Nutrient level range of mid-shoot leaves*, to find the optimum nutrient level ranges for apples.

Fertilizer requirements are adjusted to soil management practices, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered in determining the fertilizer required.

Fertilizer for Apples

Fertilizer for non-bearing apples

The best time to effectively incorporate nutrients such as phosphorous, boron and lime into the soil is prior to planting the orchard. Adequate nutrient levels in the topsoil are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 7–2, *Phosphorus and potassium soil requirements before planting apples* provides information on fertilizer rates prior to planting.

During the early years, before new trees bear their first crop, an annual application in early spring of nitrogen and potash is usually required. For suggested rates, refer to Table 7–3, *Approximate grams of actual nitrogen required per tree at various tree densities and tree ages, growing in sod*, page 70 and Table 7–4, *Approximate grams of muriate of potash required per 2.5 cm of trunk diameter at various tree densities, grown in sod*, on page 71.

On young trees broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can result if placed too close. If the soil was prepared properly, including deep cultivation and adding organic matter such as manure, there should be an adequate supply of other nutrients to sustain the orchard in the juvenile years.

On coarse-textured, infertile soils, it may help to use a starter solution at planting time (e.g., 10-52-10 or 20-20-20).

TABLE 7–2. Phosphorus and potassium soil requirements before planting apples

Soil phosphorus		Soil potassium	
New plantings of apples*		**New plantings of apples***	
Soil test (ppm P)	**Phosphates (P_2O_5) req'd kg/ha**	**Soil test (ppm K)**	**Potash (K_2O) req'd kg/ha**
0–3	80 L	0–15	180 L
4–5	60 L	16–30	170 L
6–7	50 L	31–45	160 L
8–9	40 M	46–60	140 L
10–12	20 M	61–80	110 L
13–15	0 H	81–100	70 M
16–20	0 H	101–120	40 M
21–25	0 VH	121–150	20 M
26–30	0 VH	151–180	0 H
31–40	0 VH	181–210	0 H
41–50	0 VH	211–250	0 VH
51–60	0 VH	250 +	0 E
61–80	0 E		
80 +	0 E		

* For established apple trees, use leaf analysis to estimate requirements of N, P and K.

TABLE 7–3. Approximate grams of actual nitrogen required per tree at various tree densities and tree ages, growing in sod*

	TREE DENSITY											
	hectare	**600**	**800**	**1,000**	**1,200**	**1,400**	**1,600**	**1,800**	**2,000**	**2,200**	**2,400**	**2,600**
	acre	**240**	**320**	**400**	**480**	**560**	**640**	**720**	**800**	**880**	**960**	**1,040**
Tree Age (years)	**1**	30	30	30	30	30	30	30	30	30	30	30
	2	60	60	60	60	60	60	60	60	60	60	60
	3	90	90	90								
	4	120	120	120								
	5	150	150	150								
	6	180	170	168								
	7	206	190	186								
	8	232	210	204								
	9	258	230				**Use leaf analysis to determine nitrogen needs.**					
	10	284	250									
	11	310										
	12	336										
	13 or older											

Reduce nitrogen rate by 1/2 if orchard is cultivated without sod between tree rows.
Do not exceed 200 kg of actual nitrogen/hectare/season regardless of number of trees/hectare.
* These are approximate values. The exact amount of nitrogen to apply is a function of soil nitrogen level, cultivar, rootstock, soil moisture, etc. The best way to determine nitrogen requirements is with regular leaf analysis.

High nitrogen levels can result in excessive growth and incomplete tree hardening. Cover crops are strongly recommended to check late season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass sown about July 1 take up much of the available nitrogen in the soil — checking tree growth.

Fertilizer for bearing apples

Most bearing orchards require annual applications of both nitrogen (N) and potassium (K) fertilizer. These 2 elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions including growth, fruit bud formation, fruit set and fruit size. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In some situations, if fruit tends to be small more nitrogen may be needed. Rootstocks, spacing and pruning also influence application rates.

Tree growth, foliage colour, fruit quality including colour and storability, nutrient balance in leaves and soil are also important considerations.

- Several forms of are nitrogen available, but ammonium nitrate (34-0-0) or calcium ammonium nitrate (27-0-0) is the most economical. If using blended fertilizers, request ammonium nitrate as the nitrogen source.
- Do not apply urea (46-0-0) to sod orchards since some nitrogen is lost by volatilization.

Nitrogen rates

Given the variety of orchard systems, rootstocks, cultivars and soil types, the exact amount of nitrogen to apply varies. Use leaf analysis to evaluate the nitrogen needs of specific plantings. Table 7–3 above is an estimate of possible nitrogen requirements. When the tree canopy covers the space available, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Orchards grown under clean cultivation require about 1/2 the nitrogen required by orchards grown in sod.

- For all apple cultivars do not exceed the maximum rates of 200 kg actual nitrogen per hectare per year, even in the case of a severe deficiency.

Table 7–4. Approximate grams of muriate of potash required per 2.5 cm of trunk diameter at various tree densities, grown in sod*

		TREE DENSITY											
	hectare	**< 500**	**600**	**800**	**1,000**	**1,200**	**1,400**	**1,600**	**1,800**	**2,000**	**2,200**	**2,400**	**2,600**
	acre	**< 200**	**240**	**320**	**400**	**480**	**560**	**640**	**720**	**800**	**880**	**960**	**1,040**
Tree Age (years)	1	80	80	80	80	80	80	80	80	80	80	80	80
	2	80	80	80	80	80	80	80	80	80	80	80	80
	3	80	80	80	80								
	4	80	80	80	80								
	5	80	80	80	80				**Use leaf analysis to determine potash needs.**				
	6	80	80	80	80								
	7	80	70	63	52								
	8	80	70	63	52								
	9	80	70	63	52								
	10	80	70	63	52								

Do not exceed 800 Kg of 0-0-60/hectare/season regardless of number of trees/hectare.

* These are approximate values. The exact amount of muriate of potash to apply is a function of soil potassium level, cultivar, rootstock, soil moisture, etc. The best way to determine potash requirements is by leaf analysis.

- If pruning is to be severe, cut back on nitrogen rates or eliminate for a year.
- Do not apply excessive amounts of nitrogen. Late or excessive applications result in poor fruit colour and quality. Also, available nitrogen late in the season may effect hardening off and increase the possibility of winter injury.
- In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil, limiting tree growth.
- In orchards with herbicide-treated strips under trees, allow some weed growth late in the season, which takes up extra nitrogen and helps to harden off trees and improve fruit quality.

Nitrogen placement and timing

- Apply nitrogen fertilizer in early April.
- In cultivated orchards broadcast nitrogen under the tree canopy.
- In sod orchards place the nitrogen in a band under the drip line or in the herbicide strip.

Foliar application of nitrogen

Foliar applications of urea (46% nitrogen) have been used successfully on apples when weather or crop conditions resulted in the need for additional nitrogen at a critical time. Late applications may adversely affect fruit quality.

- On apples, use no more than 2.7 kg N/1,000 L water (6 kg urea) and apply at least 2,000 L/ha starting 7–10 days after petal fall.
- Space the sprays about 10 days apart. Do not apply more than 3 times.
- Do not apply later than the end of July, or fruit quality and winter survival of the tree could be adversely affected.

Urea sprays are not a substitute for soil applications if nitrogen is required.

Phosphorus (P)

Phosphorus is not required in large amounts by apple trees. With a few exceptions, the level of phosphorus in Ontario soils is generally adequate without additional applications. Phosphorus may be required for sod or cover crop maintenance. A soil test is the best way to determine if this nutrient needs to be added to the sod cover. If indicated, apply phosphorus before planting so it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for establishing and producing fruit trees.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance. Because an excess of potassium can lead to deficiency of magnesium (Mg), avoid unnecessary potassium applications. Potassium soil test values between 120–150 ppm are considered adequate when planting tree fruits. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available, use approximate rates in Table 7–4, page 71.

Apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard apple tree in a year, regardless of how severe the potassium deficiency. When fertilizing trees on dwarfing rootstocks, consult Table 7–4 for approximate rates of muriate of potash to apply. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Leaf analysis is the most reliable guide to determining potassium requirements.

Placement and timing

- The best time to apply potassium, either separately or combined with nitrogen, is the spring. While some growers prefer the fall because of time constraints in the spring, some potassium may be lost by leaching over winter. For this reason apply in spring if possible.
- In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

Calcium (Ca)

A lack of calcium in apples is associated with fruit problems such as bitter pit of apple.

Foliar applications of calcium (Ca) to apples reduces the incidence of bitter pit and cork spot. Where these disorders have been a problem, apply 4 foliar sprays 2 weeks apart, beginning in mid-July. (See Table 7–5, *Calcium foliar sprays*, on page 73.) Where more calcium is required, additional applications can be made either by beginning earlier (mid-June) or by continuing until harvest.

Calcium advances fruit maturity, so the timing of harvest may need to be adjusted as a result of calcium foliar sprays.

Some formulations of calcium chloride ($CaCl_2$), if applied too close to harvest, have resulted in poor fruit finish. Calcium sprays must contact the fruit for uptake to be effective. Therefore water volumes capable of wetting the entire tree are required. The more calcium applied the better the control; however high concentrations of calcium can cause foliar burning.

- Do not concentrate $CaCl_2$ (77% flakes) beyond 5 kg/1,000 L of water at the mid-July timing and no more than 7 kg/1,000 L for the applications at or beyond mid-August.
- Do not apply calcium formulations containing nitrogen after the end of July, or fruit quality and storability may suffer.
- For all the formulations consult the label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual or elemental calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results, up to 12 kg/ha of actual calcium is often required in a total of 4 or more sprays.

Calcium sprays may cause foliage and/or fruit injury if applied when low temperature and wet weather delay drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Recent studies with calcium sprays on McIntosh failed to show an advantage in fruit firmness and keeping quality when fruit was stored in a regular controlled atmosphere storage for 5 $^1/_2$ months. Limit applications of calcium to fruit that has a known deficiency and/or is prone to bitter pit or cork spot. For more information on calcium disorders, consult OMAF Factsheet *Bitter Pit Control in Apples*, Order No. 00-009.

Magnesium (Mg)

Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees. Magnesium deficiency is becoming more evident in orchards, particularly where high rates of potash are used. Magnesium deficiency can lead to premature drop of fruit at harvest, especially with McIntosh. As magnesium is a part of the chlorophyll molecule, magnesium deficient trees have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium requirements.

Foliar sprays of magnesium are effective in correcting this deficiency for the current year only. (See Table 7–6, *Magnesium foliar sprays*, on page 73.)

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. Apply magnesium sulfate separately or try the mixture on a few trees first. Check manufacturer's label regarding mixing magnesium chelates[1] with pesticides.

For long-term corrections, soil applications of magnesium are required; however crop response is not usually immediate. On some soil types a single, early spring

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[1] Use chelates recommended for foliar sprays.

TABLE 7–5. Calcium foliar sprays

Timing	Product	Rate	Notes
4 sprays spaced 2 weeks apart beginning in mid–July. Additional sprays can be applied up to harvest.	Calcium chloride* (77% flakes)	5 kg/1,000 L water	NOT recommended on McIntosh or Idared Wet tree to point of runoff. Pesticides may not be compatible — check label
	Calcium nitrate	9 kg/1,000 L water	Use only if leaf nitrogen is low. Do not apply later than the end of July. For pesticide compatibility consult labels.
	Other formulations including chelates	Consult label	

* When using calcium chloride, mix required calcium in a pail of water first to be sure all product is dissolved before adding slurry to spray tank.

TABLE 7–6. Magnesium foliar sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

application of soil-applied magnesium may not work. A 2nd or 3rd application the following spring may be needed before the magnesium level in the tree improves. To be sure fruit drop is not a problem during this waiting period, apply foliar magnesium sprays for the first 2 years, in addition to soil applications.

- Use dolomitic limestone to supply magnesium and raise the soil pH on acidic soils.
- Where lime is not required, apply 5–7 kg/mature standard tree and 3–4 kg/mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer containing approximately 21% potash and 11% magnesium. Apply this material in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. Other sources of magnesium also work well as a soil application.
- If magnesium is being blended with the fertilizer, apply at least 80 kg of available magnesium per hectare when the fertilizer is spread.

Warning: Do not concentrate nutrient spray. Do not spray at temperatures above 25°C.

Micronutrients for Apples

Deficiencies of micronutrients or trace elements are not widespread in Ontario apple plantings. Boron deficiency is perhaps the most common. Deficiencies of zinc, manganese and iron appear occasionally, particularly in alkaline or high pH soils. The desirable range for micronutrients is very small. More damage is possible with excess amounts than with deficiencies.

- Do not apply micronutrients to apples except when deficiency is confirmed by leaf analysis or visible symptoms.
- Apply only the nutrient that is deficient in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency occurs mainly on alkaline soils or on sandy knolls. Apples are the most sensitive of the fruit crops to boron deficiency. Symptoms include internal breakdown of highly coloured fruit that drops prematurely. A boron concentration in apple leaf tissue in mid-July of less than 20 ppm is considered deficient.

Boron deficiencies can be corrected by foliar sprays.

- Apply foliar sprays of soluble boron fertilizers such as Solubor at rates supplying 0.2 kg of available boron/ 1,000 L water (1.0 kg Solubor/1,000 L). Two applications 10–14 days apart starting in early June is usually adequate. When there is a boron deficiency, spray at least 2,000 L/ha at each application. Other formulations of boron[1] are available. Consult manufacturer's label for rates and timing.

Boron deficiencies can also be corrected by soil application.

- Where leaf levels are less than 20 ppm, spray boron to the herbicide strip under established trees.
- Because of the narrow range between deficiency and toxicity, take care not to exceed recommended rates.
- Apply in fall or early spring so the boron will be carried further into the soil profile by rain or irrigation.
- The rate of boron to apply is 1–3 kg/ha of elemental boron (approximately 5–15 kg Solubor 20.5% B) to 1 ha of sprayed area. Ensure that the proper rate is applied based on spray width and row spacing. Boron applied to the soil surface may not be effective for the first year.
- In deficient situations apply a foliar spray for the first year that ground applications are made. Repeat applications every 3 years if leaf B levels approach the deficient level.

Excess boron causes yellowing of leaf edges and midrib, reduced yields and shortening storage life.

Iron (Fe)

Iron deficiency, commonly termed lime-induced chlorosis, is not widespread in Ontario orchards. Occasionally, 1 or 2 trees in an orchard exhibit iron-deficiency symptoms. Often these trees are located near the site of previous lime or building plaster storage, etc., where the soil pH is abnormally high.

Iron deficiency causes interveinal chlorosis of young leaves. As the condition grows more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the tree is affected. Iron chelates[1] make correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit-growing areas of Ontario. Its occurrence is closely related to the weather, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. Normally, this is not serious. Leaf manganese concentrations below 20 ppm in mid-July are considered deficient. Fruit size, yield and quality appear to be unaffected.

- If the condition is severe spray manganese sulfate at the rate of 1.3 kg of available Mn/1,000 L water (5 kg manganese sulfate) at 2,000 L/ha.
- Manganese chelates[1] also correct manganese deficiency. Consult manufacturer's label for complete information on rates and timing.

On Red Delicious apples manganese toxicity can occur on coarse-textured soils when the soil is very acidic (pH below 5.0). The symptoms known as "measles" are raised pimples on the bark underlain by dark brown spots. Other visual symptoms are leaf chlorosis, tip dieback, early leaf abscission and reduced flower bud development and shoot growth. Correction is sometimes possible by working lime into the soil to raise pH. Sample the soil and add lime if pH is low prior to planting.

Zinc (Zn)

The symptoms of zinc deficiency are short internodes, small narrow leaves, interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes", giving rise to the typical "rosette" and "little leaf" description for zinc deficiency. Except in severe cases, only a few shoots on an otherwise normal tree show symptoms. Leaf zinc levels below 15 ppm indicate a deficiency. To correct zinc deficiency:

- Apply zinc sulfate, supplying 3.6 kg of Zn/1,000 L water as a dormant spray in early spring.
- In June apply dilute sprays of zinc sulfate ($ZnSO_4$) or chelate[1] containing 0.35 kg Zn/ha (1 kg 36% $ZnSO_4$ or 5 L 6.5% Zn chelate).
- A fungicide for disease control that contains available zinc can be an asset in orchards continually low in zinc. Consult manufacturer's label for available zinc concentrations in the formulation.

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[1] Use chelates recommended for foliar sprays.

APPLE CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 7–7, *Days to harvest intervals for products used on apples,* on page 86.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Dormant			
San Jose scale European fruit scale Lecanium scale	• Superior "70" Oil	20 L of oil/1,000 L of water	Apply full rate of oil in 2,000–3,000 L of water/ha. 3,000 L gives best results. On large standard trees, use 90 L of oil in 4,500 L of water/ha. Do not apply full rate of oil more than once/season. Test the stability of the emulsion by shaking in a jar. Do not use oil within 48 hours of freezing temperatures. Do not use oil within 14 days of Captan or Maestro.
	OIL MAY CAUSE BARK INJURY ON RED DELICIOUS, EMPIRE AND MUTSU (CRISPIN).		
Green tip up to half-inch green			
Scab protectants	• Manzate 200 DF or Dithane DG or [3]Penncozeb 75 DF • Polyram DF • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [4]Dikar • [4]Vangard 75 WG	6.00 kg 6.00 kg see label 6.00 kg 3.75 kg 3.75 kg 6.75 kg 370 g	Apply fungicide before spore release and keep growing leaves covered. Alternate materials in a spray program. Read *Apple Scab* on page 97. When used in a full season program, Dikar will suppress mites. Higher water volumes help mite suppression. Consult label. Use Vangard as a protectant fungicide. Make no more than 2 applications/season, prebloom only. Vangard does not control other foliar or fruit diseases.
Half-inch green to tight cluster			
European red mite	• Superior "70" Oil	20 L of oil/ 1,000 L of water	Do not apply full rate of oil more than once/season. Apply oil in 2,000–3,000 L of water/ha. 3,000 L gives best results. On large standard trees, use 90 L of oil in 4,500 L of water/ha. Test the stability of the emulsion by shaking in a jar. Apply Superior "70" Oil for the control of European red mite before overwintering eggs hatch. Usually the best timing is between **Half-inch green and Tight cluster** when temperatures are getting warmer. Do not use oil within 14 days of Captan or Maestro.
	OIL MAY CAUSE BARK INJURY ON RED DELICIOUS, EMPIRE AND MUTSU (CRISPIN).		
Rosy apple aphid	• [3]Pirimor 50 DF • [2]Assail 70 WP	1.7 kg 120 g	Some countries have zero tolerance for Pirimor residues on fruit. Check with your packer before applying this material. Do not make more than 2 applications of Pirimor/season. Alternate Assail with insecticides from different chemical families. Maximum of 4 applications of Assail/season.

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[1] *Minimum period for re-entry is 4 hr.* [2] *Minimum period for re-entry is 12 hr.* [3] *Minimum period for re-entry is 24 hr.* [4] *Minimum period for re-entry is 48 hr.* [5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.* [8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Scab	• Manzate 200 DF	6.00 kg	See *Apple Scab* on page 97. Do not use Sovran or Flint earlier than **Tight cluster** and apply in blocks of 2 applications, 10 days apart. Use another chemical family for 2 applications before returning to these products. Use no more than 4 applications of Sovran or Flint/season. After last application of Sovran or Flint, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check labels for details. See *Use of strobilurin fungicides* on page 101 and *Use of demethylation inhibitor (DMI) fungicides (sterol-inhibitors)* on page 100. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
	or Dithane DG	6.00 kg	
	or [3]Penncozeb 75 DF	see label	
	• Polyram DF	6.00 kg	
	• [4]Supra Captan 80 WDG	3.75 kg	
	or [4]Maestro 80 DF	3.75 kg	
	• [4]Dikar	6.75 kg	
	• [8]Sovran	240 g	
	• Nova 40 W	340 g	
	plus Dithane DG	3.00 kg	
	• Nova 40 W	340 g	
	plus Polyram DF	3.00 kg	
	• Nova 40 W	340 g	
	plus [4]Maestro 80DF	1.90 kg	
	• [2]Nustar	100 g	
	plus Manzate 200 DF	3.00 kg	
	• [2]Nustar	100 g	
	plus[4]Maestro 80 DF	1.90 kg	
	• [4]Vangard 75 WG	370 g	
	• [2]Flint 50 WG	140 g	When mixing fungicides with oil, add fungicide to tank when $^1/_4$ to $^1/_2$ full of water and mix thoroughly. Add Superior "70" Oil last when tank is at least $^3/_4$ full of water. Do not use oil within 14 days of Captan or Maestro. **Note:** Oil may cause bark injury to Red Delicious, Empire and Crispin.
	• With Superior "70" Oil use 1 of:		
	• Polyram DF	6.00 kg	
	• Dithane DG	6.00 kg	
	or Manzate 200 DF	6.00 kg	
Powdery mildew	Use one of the products listed at **Tight cluster to pink.**		
Oriental fruit moth	• Isomate M100	250 dispensers/ha	**Pheromone mating disruption products are not insecticides, and will not control other pests that may be present in the orchard.** Initial OFM population must be low. Apply to square or rectangular orchard blocks at least 4 ha in size. These products must be applied before a given generation of OFM flight begins. For more information on mating disruption see *Oriental fruit moth* on page 91 and OMAF Factsheet *Mating Disruption for Management of Insect Pests*, Order No. 03-079. Apply a 2nd application of Isomate M100 up to 75–80 days after initial application. Isomate Rosso provides control for up to 120 days. Regardless of the product used take note of field longevity. Do not leave the crop unprotected late in the season.
	• Isomate Rosso	500 dispensers/ha	
Tight cluster to pink			
Tentiform leafminer	• [2]Assail 70 WP	80 g/ha	Consult agriphone for timing (if available). Do not apply Assail more than 4 times/season. Apply Confirm at first egg hatch. Confirm suppresses leafminer populations. Continue monitoring after application. Do not apply Confirm more than 2 times/season. _*Pyrethroids also control spring feeding caterpillars and tarnished plant bugs. Do not apply a pyrethroid more than once/season. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite._
	• *Pounce	520 mL	
	• *Decis 5 EC	250 mL	
	• *Ripcord 400 EC	250 mL	
	or *Cymbush 250 EC	400 mL	
	• [3]*Matador 120 EC	83 mL	
	• Confirm 240 F	1.00 L	
Scab	Use one of the fungicides listed at **Half-inch green to tight cluster**. See also *Control of apple scab under adverse weather conditions* on page 101.		

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[1] *Minimum period for re-entry is 4 hr.* [2] *Minimum period for re-entry is 12 hr.* [3] *Minimum period for re-entry is 24 hr.* [4] *Minimum period for re-entry is 48 hr.*
[5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.*
[8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Powdery mildew	• Nova 40 W • [2]Nustar • [8]Sovran • [4]Dikar • Microscopic sulphur • Kumulus DF • [2]Flint 50 WG	340 g 200 g 240 g 6.75 kg see label 22.5 kg 140 g	Begin application at tight cluster and continue to **First summer spray.** If powdery mildew was prevalent the previous year, apply fungicides beginning at **Green tip.** Additional sprays beyond **First summer spray** may be needed on susceptible varieties or if disease pressure is severe. See Table 7–14, *Examples of apple cultivars susceptible to key diseases,* on page 102. Do not apply Nova or Nustar more than 4 times/season. Do not apply Flint or Sovran more than 4 times/season. See *Use of strobilurin fungicides* on page 101 and *Use of demethylation inhibitor (DMI) fungicides (sterol-inhibitors)* on page 100. Do not use Sulphur or Kumulus on Delicious because these products can cause an increase in red mite and scale insects populations.
Cedar apple rust Quince rust	• Ferbam 76 WDG • [4]Dikar • Polyram DF • Dithane DG or [3]Penncozeb 75 DF • Nova 40W plus Dithane DG • [2]Flint 50 WG	see label 6.75 kg 6.00 kg 6.00 kg see label 340 g 3.00 kg 140 g	Include in each spray up to and including **First summer spray.** Ferbam may cause russetting on Golden Delicious and other sensitive varieties. Do not apply Nova more than 4 times/season. Do not apply Flint more than 4 times/season.
Plant bugs	• Cygon 480-AG or Lagon 480 E	see label see label	Where plant bug is a problem, add to 1 spray before bloom. Also controls spring-feeding caterpillars and green fruitworm. Cygon and Lagon may cause russetting in some varieties.
Spring-feeding caterpillars Green fruitworm	• Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [3]Zolone Flo	3.75 kg see label see label 2.00 L	This spray is not necessary if a pyrethroid was applied for tentiform leafminer. Do not apply Zolone more than 3 times/season.
Pink			
Scab	Use 1 of the fungicides listed at **Half-inch green to tight cluster.** See *Control of apple scab under adverse weather conditions* on page 101.		
European red mite	• Carzol SP	1.10 kg	Miticides are most effective when used alone. Carzol is harsh on beneficial mite species and bees. Application before **Petal fall** is preferred.
SEE PEST RESISTANCE TO INSECTICIDES, FUNGICIDES, MITICIDES ON PAGE 44.			
Rosy apple aphid	• [3]Pirimor 50 DF • [2]Assail 70 WP • [3]Zolone Flo • Cygon 480-AG or Lagon 480 E	1.70 kg 120 g 2.00 L see label see label	Preferred time for control. See section on *Bee Poisoning* on page 64. Do not apply Pirimor more than 2 times/season. Some countries have zero tolerance for Pirimor residues on fruit. Check with your packer before applying this material. Do not apply Assail more than 4 times/season. Do not apply Zolone more than 3 times/season. Cygon and Lagon may cause russetting.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Obliquebanded leafroller	• *Dipel 2X DF	1.12 kg	See *Obliquebanded leafroller* on page 91. When applied for leafroller control, these products also control other caterpillars. Apply Success when larvae are small. Monitor populations and re-apply as necessary on a 7–10 day schedule. Spray solution should be above pH 6.0. Do not apply Success more than 3 times/season. Accurate timing of Confirm is important. See label for specific timing. Do not apply Confirm more than 2 times/season. Avoid treating sequential generations with the products from the same chemical family. See Table 4–1, *Insecticide and miticide groups based on sites of action*, on page 46. * Make 2 applications of B.t. products at 5–7 day intervals if activity of the larvae is extended. For best results when using B.t. products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.
	or *Foray 48BA	2.80 L	
	or *Bioprotec CAF	4.00 L	
	• [2]Success 480 SC	182 mL	
	• Confirm 240 F	1.00 L	
Bloom			
DO NOT APPLY INSECTICIDES WHILE APPLE TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.			
Scab	• Polyram DF	6.00 kg	See *Control of apple scab under adverse weather conditions* on page 101. Do not use Sovran or Flint earlier than **Tight cluster** and apply in blocks of 2 applications, 10 days apart. Use another chemical family for 2 applications before returning to these products. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47. After last application of Sovran or Flint, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications. Check label for details. Do not apply Sovran or Flint more than 4 times/season. See *Use of strobilurin fungicides* on page 101 and *Use of demethylation inhibitor (DMI) fungicides (sterol-inhibitors)* on page 100.
	• [4]Supra Captan 80 WDG	3.75 kg	
	or [4]Maestro 80 DF	3.75 kg	
	• [4]Dikar	6.75 kg	
	• Manzate 200 DF	6.00 kg	
	or Dithane DG	6.00 kg	
	or [3]Penncozeb 75 DF	see label	
	• [8]Sovran	240 g	
	• Nova 40 W	340 g	
	plus Dithane DG	3.00 kg	
	• Nova 40 W	340 g	
	plus Polyram DF	3.00 kg	
	• Nova 40 W	340 g	
	plus [4]Maestro 80DF	1.90 kg	
	• [2]Nustar	100 g	
	plus Manzate 200 DF	3.00 kg	
	• [2]Nustar	100 g	
	plus [4]Maestro 80 DF	1.90 kg	
	• [2]Flint 50 WG	140 g	
Fire blight	• [8]Streptomycin 17	600 g/1,000 L	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Streptomycin 17 is UV light sensitive and is only effective for 2–3 days. Re-application is needed after 2–3 days if warm, wet conditions (above 20°C) prevail. Two–3 sprays during bloom may be required for fire blight control. Do not apply streptomycin more than 3 times/season. See *Fire blight* on page 95 for details.
Petal fall (Calyx) when most petals have fallen			
Scab	Use one of the fungicides recommended at **Bloom**. See *Control of apple scab under adverse weather conditions* on page 101.		

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[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Tentiform leafminer	• Agri-Mek 1.9 EC • [3]Admire • [2]Assail 70 WP • *Pounce • *Decis 5 EC • *Ripcord 400 EC or *Cymbush 250 EC • *[3]Matador 120 EC • [3]Lannate	750 mL 380 mL 80 g 520 mL 250 mL 250 mL 400 mL 83 mL 1.60 kg	Apply Agri-Mek when first sap-feeding mine is detected. Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L of Superior "70" Oil and a minimum of 1,000 L of water/ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned cultivars. **Do not use Agri-Mek plus oil within 14 days of Captan or Maestro application.** Do not apply more than once/season. Agri-Mek plus oil is best applied alone. Agri-Mek also controls ERM and TSSM. Apply Admire or Assail when sap feeders are present. Will also control other sap-feeding insects at this timing. Alternate Assail or Admire with insecticides from different chemical families. Do not apply Assail more than 4 times/season. Do not apply Admire more than 2 times/season. In years where leafminer egg hatch is delayed, a pyrethroid* can be applied at petal fall when first sap-feeding mine is detected. This treatment also controls tarnished plant bug and spring feeding caterpillars. Apply Lannate when first tissue-feeding mine is detected on the upper surface of the cluster leaves. Do not apply Lannate to Early McIntosh or Wealthy varieties. * *Do not apply pyrethroids more than once/season. Pyrethroids are highly toxic to beneficial insects, and may lead to outbreaks of European red mite.*
Rosy apple aphid	• [3]Admire • [2]Assail 70 WP • [3]Pirimor 50 DF • [3]Zolone Flo • Cygon 480-AG or Lagon 480 E	230 mL 120 g 1.70 kg 2.00 L see label see label	Admire or Assail applied at this time also control sap feeding insects. Do not apply Admire more than 2 times/season. Do not apply Assail more than 4 times/season. Some countries have zero tolerance for Pirimor residues on fruit. Check with your packer before applying this material. Cygon and Lagon may cause russetting.
Mullein leaf bug	• [3]Admire • Diazinon 50 W • [3]Lannate	380 mL 3.25 kg 1.60 kg	Timing is critical. Admire applied at this time also controls green apple aphid, rosy apple aphid, white apple leafhopper, and tentiform leafminer. Do not apply Admire more than 2 times/season.
Oystershell scale San Jose scale	• [9]Guthion Solupak or [9]Sniper	see label see label	Apply when the crawlers are active.
Plum curculio Caterpillars	• [9]Guthion Solupak or [9]Sniper • Imidan 50 WP • [3]Zolone Flo	see label see label 3.75 kg 3.00 L	
European apple sawfly	• [9]Guthion Solupak or [9]Sniper	see label see label	Apply as a special spray to orchards where there has been a history of damage.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
European red mite	• Agri-Mek 1.9 EC • Apollo SC • Carzol SP	750 mL 300 mL 1.10 kg	Apply Agri-Mek when mites are in the nymph stage and no later than 21 days after petal fall. Apply with 10 L Superior "70" Oil and a minimum of 375 L of water /ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned varieties. **Do not use Agri-Mek plus oil within 14 days of a Captan or Maestro application. Do not apply more than once per season.** Ideally, alternate yearly with other early season miticides (e.g., Superior "70" Oil, Apollo). Agri-Mek also controls tentiform leafminer. Apollo kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites/leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water/ha. Do not apply Apollo more than once/season. Carzol is harsh on beneficial insects, mites and bees.
Blister spot	• Aliette WDG	2.00 kg	Begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not exceed 3 applications/season. Do not mix with copper compounds.
Obliquebanded leafroller	• *Dipel 2X DF or *Foray 48BA or *Bioprotec CAF • [2]Success 480 SC • Confirm 240 F • [3]Lannate	1.12 kg 2.80 L 4.0 L 182 mL 1.00 L 1.60 kg	See *Obliquebanded leafroller* on page 91. When applied for leafroller control, these products also control other caterpillars. Apply Success when larvae are small. Monitor populations and re-apply as necessary on a 7–10 day schedule. Do not apply Success more than 3 times/season. Spray solution should be above pH 6.0. Do not apply Confirm more than 2 times/season. Accurate timing of Confirm is important. See label for specific timing. Avoid treating sequential generations with the products from the same chemical family. See Table 4–1, *Insecticide and miticide groups based on sites of action*, on page 46. Lannate is most effective on 4th and 5th instar larvae. Do not use Lannate more than once/season. * Make 2 applications of B.t. products at 5–7 day intervals if activity of the larvae is extended. For best results when using B.t. products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.
Oriental fruit moth	• *Decis 5EC • [2]Assail 70 WP	250 mL 240 g	See *Oriental fruit moth* on page 91. Apply as a special spray to orchards where there is a history of damage. Begin applications at peak egg hatch based on pheromone trap counts and degree days. Do not apply Assail more than 4 times/season. * *Do not apply pyrethroids more than once/season. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite. Use only as a last resort.*
Powdery mildew	Use one of the fungicides listed at **Tight cluster to pink.**		
First summer spray (7–10 days after Calyx)			
Scab	Use one of the fungicides recommended at **Bloom.** An extra scab spray may be required between **Calyx** and **First summer spray.** See *Control of apple scab under adverse weather conditions* on page 101.		
Plum curculio	Use one of the insecticides listed under **Petal fall (calyx).**		
Fire blight	• [8]Streptomycin 17	600 g/1,000 L	Apply up to 14 days after petal fall to control shoot blight especially if blossom blight has occurred.

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Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
European red mite Two-spotted spider mite	• Apollo SC • Agri-Mek 1.9 EC	300 mL 750 mL	Apply Apollo no later than 14 days after petal fall. Apollo kills mite eggs. Apply when mites are mostly in the egg stage and before there are more than 3 active mites/leaf. Thorough coverage is essential for good control. Apply Apollo alone in a minimum of 1,100 L of water/ha. Do not apply Apollo more than once/season. Apply Agri-Mek when mites are in the nymph stage and no later than 21 days after petal fall. Apply with 10 L Superior "70" Oil and a minimum of 375 L of water/ha. Agri-Mek plus oil may cause russetting to Golden Delicious and other light-skinned varieties. **Do not use Agri-Mek plus oil within 14 days of a Captan or Maestro application. Do not apply Agri-Mek more than once/season.** Ideally, alternate yearly with other early season miticides (e.g., Superior "70" Oil, Apollo). Agri-Mek also controls tentiform leafminer. Miticides are best applied alone. Resistance to miticides is increasing in Ontario orchards. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44.
Rosy apple aphid	• [3]Admire • [2]Assail 70 WP • [3]Pirimor 50 DF • [3]Zolone Flo • Cygon 480-AG or Lagon 480 E	230 mL 120 g 1.70 kg 2.00 L see label see label	Admire or Assail applied at this time also control green apple aphid and white apple leafhopper. Do not apply Admire more than 2 times/season. Do not apply Assail more than 4 times/season. Some countries have zero tolerance for Pirimor 50 DF residues on fruit. Check with your packer before applying this material. Cygon or Lagon may cause russetting.
Powdery mildew	Use one of the fungicides listed under **Tight cluster to pink.**		
Blister spot	• Copper 53W • Aliette WDG	3.00 kg 2.00 kg	To reduce the incidence of blister spot lesions on Crispin and other sensitive varieties, apply up to 3 applications of Copper 53W beginning 10 days after **Petal fall**. Use hydrated lime as a safener (to reduce the risk of phytotoxicity) at a rate of 6 kg per 1 kg of Copper 53W per 1,000 L of water. Apply 3,000 L of water/ha. For Aliette begin applications at petal fall with 1–2 subsequent sprays at 7 day intervals. Do not exceed 3 applications. Do not mix with copper compounds.
Oriental fruit moth	• Isomate M 100 • Isomate Rosso	250 dispensers/ha 500 dispensers/ha	See *Oriental fruit moth* on page 91 for details on OFM control with these products. Refer to mating disruption comments listed under **Half-inch green to tight cluster.** Apply a 2nd application of Isomate M 100 75–80 days following the first application. Isomate Rosso will provide control for up to 120 days.
Subsequent summer sprays			
Scab	Until the end of the primary scab season use one of the fungicides recommended at **Bloom.** For summer (secondary) scab infections, use one of the following:		
	• [4]Supra Captan 80 WDG or [4] Maestro 80 DF • [4]Dikar WP • Polyram DF • Manzate 200 DF or Dithane DG or [1]Penncozeb 75 DF	3.75 kg (1.9) 3.75 kg (1.9) 6.75 kg 6.00 kg (4.5) 6.00 kg (5.0) 6.00 kg (4.5) see label	**If scab is controlled in your orchard use the lower rate given in brackets.** If secondary lesions develop, see *Deactivation of established scab lesions* on page 102. Do not apply Polyram, Dikar, Manzate 200, Dithane or Penncozeb within 45 days of harvest.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
Sooty blotch Fly speck	• [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Flint 50 WG	3.75 kg 3.75 kg 140 g	Repeat application of Captan or Maestro in 2 weeks. Captan or Maestro at full rates, provide protection against black rot. Do not apply Flint more than 4 times/season.
Codling moth	• Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [1]Zolone Flo • Confirm 240 F • [2]Assail 70WP	3.75 kg see label see label 2.00 L 1.00 L 170 g/ha	Use pheromone traps to time sprays. See OMAF Publication 310, *Integrated Pest Management for Ontario Apple Orchards* for information on how to monitor for this pest. Guthion and Sniper control scale crawlers. Zolone also controls aphids. Apply Confirm at first egg hatch. Confirm may also suppress leaf-feeding caterpillars. Do not apply more than 2 times/season. Confirm **does not** control apple maggot. Accurate timing of Confirm is important. See label for specific timing. Do not apply Assail more than 4 times/season.
Oriental fruit moth	• Isomate M 100 • Isomate Rosso	250 dispensers/ha 500 dispensers/ha	See *Oriental fruit moth* on page 91 for details on OFM control with these products. Refer to mating disruption comments listed under **Half-inch green to tight cluster** section. Apply a 2nd application of Isomate M100 75–80 days following 1st application. Isomate Rosso provides control for up to 120 days.
Apple maggot	• Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [3]Zolone Flo • Cygon 480-AG or Lagon 480 E • Sevin XLR Plus • Diazinon 50 W	3.75 kg see label see label 3.00 L see label see label 6.25 L see label	See *Apple maggot* on page 88. Base initial spray on trap catches. Make subsequent applications at 14–21 day intervals or as required based on monitoring. Cygon or Lagon may not give sufficient apple maggot control for fresh market apples and may cause russetting on some varieties.
Special summer sprays			
Blister spot	• Copper 53 W • Aliette WDG	3.00 kg 2.00 kg	See comments on blister spot control under **First summer spray.**
Green apple aphid Rosy apple aphid	• [3]Admire • [2]Assail 70WP • [3]Pirimor 50 DF • [3]Zolone Flo • Cygon 480-AG • or Lagon 480 E • Thiodan 50 WP or Endosulfan 50 W • Diazinon 50 W	230 mL 120 g 1.70 kg 2.00 L see label see label 4.50 kg 4.50 kg see label	Do not apply Admire more than 2 times/season. Do not apply Assail more than 4 times/season. Zolone also controls woolly apple aphid. Diazinon, Cygon or Lagon and Zolone also control codling moth and apple maggot. Pirimor, Admire, Assail, Thiodan and Endosulfan also control white apple leafhopper. Some countries have zero tolerance for Pirimor residues on fruit. Check with your packer before applying this material. Cygon and Lagon may cause russetting.
Woolly apple aphid	• [3]Pirimor 50 DF • Malathion 25 W • [3]Zolone Flo	1.70 kg see label 2.00 L	Use high volumes of water and ensure spray contacts trunk and scaffold limbs. Repeat application in 14 days if woolly apple aphid is still present. Pirimor also controls white apple leafhopper. Some countries have zero tolerance for Pirimor residues on fruit. Check with your packer before applying this material. Zolone is effective only if used in a cover spray program.

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[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
White apple leafhopper	• [3]Admire • [2]Assail 70WP • [1]Pirimor 50 DF • Carzol SP • Sevin XLR plus • Endosulfan 50 W	200 mL 120 g 1.70 kg 1.10 kg 3.10 L 2.60 kg	Spray when nymphs are present (2–5 per leaf). Control of adults is very difficult. There are 2 generations of nymphs/season, in mid-June and early August. When Admire or Assail is applied for 1st generation, it also controls green apple aphid and rosy apple aphid. Do not apply Admire more than 2 times/season. Do not apply Assail more than 4 times/season. Some countries have zero tolerance for Pirimor residues on fruit. Check with your packer before applying this material.
Potato leafhopper	• Endosulfan 50 W • [2]Assail 70WP	2.60 kg 120 g	Do not apply Assail more than 4 times/season.
Tentiform leafminer	• [3]Admire • [2]Assail 70 WP • *Pounce • *Decis 5EC • *Ripcord 400 EC or *Cymbush 250 EC • *[3]Matador 120 EC	380 mL 80 g 520 mL 250 mL 250 mL 400 mL 83 mL	Apply Admire or Assail when populations are mainly in the sap-feeder stage. Do not apply Admire more than 2 times/season. Do not apply Assail more than 4 times/season * *Use of synthetic pyrethroids for summer generations of tentiform leafminer is discouraged. Pyrethroids do not give effective control of larvae within the mines. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite.*
Dogwood borer Apple bark borer	• Pounce plus Superior Oil	22 mL/100 L water with 2 L oil	Soak the trunk. Make 2 applications at 2–3 week intervals when adults are flying (late June–early August).
Obliquebanded leafroller	• *Dipel 2X DF or *Foray 48BA or *Bioprotec CAF • [2]Success 480 SC • Confirm 240 F	1.12 kg 2.80 L 4.00 L 182 mL 1.00 L	When applied for leafroller control, these products also control other leaf-feeding caterpillars. Apply Success when larvae are small. Monitor populations and re-apply as necessary on a 7–10 day schedule. Make no more than 3 applications. Spray solution should be above pH 6.0. Apply a 2nd spray of Confirm 10–14 days after the 1st application. Do not apply Confirm more than 2 times/season. Accurate timing of Confirm is important. See label for specific timing. Avoid treating sequential generations with the products from the same chemical family. See Table 4–1, *Insecticide and miticide groups based on sites of action*, on page 46. * Make 2 applications of B.t. products at 5–7 day intervals if activity of the larvae is extended. For best results when using B.t. products, acidify spray mix to below pH 7.0 and apply at dusk or on overcast days.
Oriental fruit moth	• *Decis 5EC • [2]Assail 70 WP	250 mL/ha 240 g/ha	Apply as a special spray to orchards where there has been a history of damage. Begin applications at peak egg hatch based on pheromone trap counts and degree days. Rotate between products in different chemical families to deter the development of pesticide resistance. See Table 4–1, *Insecticide and miticide groups based on sites of action*, on page 46. * *Do not apply pyrethroids more than once/season. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite. Use only as a last resort.*

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[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha trees 4.5–5.5 m high	Comments
European red mite Two-spotted spider mite Rust mite	• [1]Pyramite • Kelthane 50 W • Carzol SP	300 g 3.25 kg 1.10 kg	Pyramite is most effective when applied to immature stages (but not eggs). A higher rate of 600 g/ha may be necessary if outbreaks of two-spotted mites occur. Carzol is harsh on beneficial mite species. Use established spray thresholds to time miticide applications. Miticides are best used alone. Apply each miticide only once/season to delay development of resistance. Use a minimum of 1,000 L/ha of water when applying summer miticides. Resistance to miticides is increasing in Ontario orchards. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44.
Pinpoint and storage scab	Use one of the fungicides recommended for secondary scab in **Subsequent summer sprays**. Do not use fungicides closer than the stated interval to harvest. (See Table 7–7, *Days to harvest intervals for products used on apples*, on page 86.)		
Postharvest treatment			
Blue mould Grey mould	• Mertect SC	0.5 L/500 L	For use in dip tank or drencher. Continuous agitation is required. Follow label instructions. **Does not control blue mould (Penicillium) or grey mould (Botrytis), that are resistant to benzimidazole fungicides.** Summer applications of Captan and Maestro provide some protection against storage rots.

Guidelines for Protecting Non-Bearing Apple Plantings

The following program is designed to offer limited protection when needed for newly planted trees. It is not intended for protection of bearing orchards. To minimize pest pressure, remove neglected fruit trees in the area, and control weeds. Alternate materials are available as shown in the calendar for bearing fruits.

Diseases and Insects	Materials	Comments
Early spring		
Phytophthora collar rot		See *Phytophthora collar rot* on page 96.
First spray		
Powdery mildew	• Nova 40 W • [2]Nustar • [8]Sovran • [2]Flint 50 WG • [4]Dikar	
Scab	• [4]Dikar • Manzate 200 DF or Dithane DG or [3]Penncozeb 75DF • Polyram DF • [4]Supra Captan 80 WDG or [4]Maestro 80 DF	When green tissue shows. Repeat at 7–10 day intervals if wet weather occurs until late June.

Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Comments
Prebloom		
Tentiform leafminer	• [2]Assail 70 WP • *Pounce • *Decis 5EC • *Ripcord 400 EC or *Cymbush 250 EC • [5]*Matador 120 EC • Confirm 240 F	* *Do not apply pyrethroids more than once/season. Pyrethroids are highly toxic to beneficial insects and may lead to outbreaks of European red mite.*
Leaf-feeding caterpillars	• Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [5]Zolone Flo	Before blossoms open in adjacent bearing orchards. Apply when caterpillars are small. Include with a fungicide spray. Not necessary if a pyrethroid was used for tentiform leafminer.
Bloom		
Fire blight	• [8]Streptomycin 17	Avoid overstimulating growth. See *Fire blight* on page 95.
Summer sprays		
Leaf-feeding insects	• Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [5]Zolone Flo	This spray will also control potato leafhopper.
Aphids	• [3]Admire • [2]Assail 70 WP • [3]Pirimor 50 DF • Cygon 480-AG • Thiodan 50 WP or Endosulfan 50 W • Diazinon 50 W	Spray if insects become abundant at any time.
White apple leafhopper	• [3]Admire • [2]Assail 70 WP • [3]Pirimor 50 DF • Endosulfan 50 W	
Potato leafhopper	• Endosulfan 50 W • Thiodan 50 WP • [2]Assail 70 WP	
Tentiform leafminer	• [3]Admire • [2]Assail 70 WP • [3]Vydate L	Vydate is very toxic to applicator. Timing is critical. If mines are visible on underleaf surface, consult crop consultant.
Mites	• [3]Pyramite • Kelthane 50 W • Carzol SP	Check foliage frequently for mite injury. Spray if more than 10 mites/leaf are observed or at first sign of leaf bronzing.
Buffalo treehopper		Follow clean cultivation practices or remove legumes from cover crop.
Phytophthora collar rot	See *Phytophthora collar rot* on page 96.	
Root lesion nematode	See *Nematodes in tree fruits* on page 49 and *VYDATE L — postplant treatment* on page 51.	

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 7–7. Days to harvest intervals for products used on apples

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the number of days between the last spray and first harvest. The re-entry period is the minimum interval that must be observed between applying the pesticide and working in the treated crop without protective equipment. If no re-entry period is stated on the label, assume that the spray solution must be dry before re-entry can occur. The maximum number of applications is the labelled maximum number for the growing season, and may be higher than what is recommended for resistance management or for preserving beneficial insects.

Product name	Preharvest interval	Minimum re-entry period	Maximum number of applications per season
Admire 240F	7 days	24 hours	2
Agri-Mek 1.9 EC	28 days	—	1
Aliette WDG	30 days	—	3
Apollo SC	No later than 14 days after petal fall	—	1
Assail 70 WP	7 days	12 hours	4
Bioprotec CAF	1 day	—	—
Supra Captan 80 WDG	7 days	48 hours	—
Carzol SP	21 days	—	—
Confirm 240F	14 days	—	4
Copper 53W	30 days	—	3
Cygon 480-Ag	14 days	—	—
Cymbush 250 EC	7 days	—	3
Decis 5 EC	1 day	—	3
Diazinon 50W	14 days	—	—
Dikar	45 days	48 hours	—
Dipel 2X DF	—	—	—
Dithane DG	45 days	—	—
Endosulfan 50W	15 days	—	Depends on pests
Ferbam 76 WDG	7 days	—	—
Flint 50WG	14 days	12 hours to 4 days	4
Foray 48BA	—	—	—
Funginex 190EC	Non-bearing only	—	—
Guthion Solupak	14 or 21 days depending on rate	48 hours to 14 days see label	10.1 kg/ha see label
Imidan 50 WP	1 day	—	—
Kelthane 50 W	7 days	—	1
Kumulus DF	1 day	—	—
Lannate	8 days	24 hours	—
Maestro 80 DF	7 days	48 hours	—
Manzate 200 DF	45 days	—	—
Matador 120 EC	7 days	24 hours	3
Microscropic Wettable Sulphur	1 day	—	—
Nova 40 W	14 days	—	6
Nustar	77 days	12 hours	4
Pennocozeb 75 DF	45 days	24 hours	—
Polyram DF	45 days	—	—
Pounce	7 days	—	—
Primor 50 DF	35 days	24 hours	1–2
Pyramite 75 WP	25 days	24 hours	2

TABLE 7–7. Days to harvest intervals for products used on apples (cont'd)

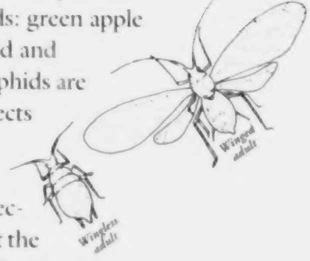
Product name	Preharvest interval	Minimum re-entry period	Maximum number of applications per season
Ripcord 400 EC	7 days	—	2–3
Ridomil Gold 480 EC	non-bearing only	—	3
Sevin XLR Plus	11 days	—	—
Sniper	14 days	48 hours to 14 days	8
Sovran	30 days	4 hours to 7 days	4
Streptomycin 17	50 days	24 hours to 14 days	max. 5.4 kg/ha
Success 480 SC	7 days	12 hours	3
Superior "70" Oil	—	—	1 (full rate)
Thiodan 4 EC	15 days	—	2
Thiodan 50 WP	15 days	—	2 applications after calyx
Vangard 75 WG	72 days	48–72 hours	6
Vydate L	Non-bearing only	48 hours	—
Zolone Flo	30 days	24 hours	3

NOTES ON APPLE INSECTS

For more information in insects and diseases, refer to OMAF Publication 310, *Integrated Pest Management in Ontario Apple Orchards.*

Aphids

Identification



Three species of aphids are pests in Ontario apple orchards: green apple aphid, rosy apple aphid and woolly apple aphid. Aphids are small, soft-bodied insects that can be distinguished from other similar insects by projections called cornicles at the posterior end of their bodies. Aphids weaken plants by removing sap, causing wilting, curling or yellowing of leaves. They can also transmit diseases such as fire blight throughout the orchard. Aphids secrete a substance called honeydew that promotes the development of black sooty mould on leaf and fruit tissues.

Rosy apple aphids inject a toxin into the plant during feeding. This toxin causes the fruit and leaves to deform, causing stunted fruit.

Period of activity

Aphids are present in the orchard from petal fall through August. Female aphids can produce live young without mating and there are multiple generations per year. Aphid populations can increase dramatically when environmental conditions are ideal.

Monitoring and thresholds

Thresholds vary depending on the type of aphid present. Scout for green aphids by examining 10 terminals on 10 trees throughout the orchard. Take control measures when there are 400–600 aphids per terminal on 10% or more of the terminals examined.

For rosy apple aphids, examine 10 fruit clusters from each of 10 trees for the presence of aphids and predators. A fruit cluster is considered infested if more than 20 aphids are present. Control is recommended if more than 10% of the fruit clusters are infested and few predators are identified.

Currently there are no thresholds for woolly apple aphids.

Apple maggot

Identification

Apple maggot (AM) adults are slightly smaller than houseflies. The thorax is marked with a white dot. F-shaped black banding on the wings is unique and helps to distinguish apple maggot from other fruit flies found in the orchard See Figure 7–2, *Wing patterns of apple maggot and related species*. Apple maggot females lay eggs under the skin of apples, causing dimples to form on the fruit surface. The larvae emerge from these eggs and burrow through the fruit, causing brown internal tunnelling.

Period of activity

Generally there is one generation of apple maggot per year in Ontario; a partial 2nd generation can occur in some years. Apple maggots overwinter as pupae in the soil. Adult flies emerge from late June through September with peak flight occurring in August. Emergence is closely linked to soil moisture levels and in dry years the pupae may not emerge until the following growing season.

Monitoring and thresholds

Apple maggots are monitored using rectangular yellow sticky boards and scented baits. Place 5 traps, with baits attached, in trees along the edge of the orchard, adjacent to wood lots with wild hosts. Place the traps at eye level in the trees in mid to late June. Check traps twice a week for the presence or absence of flies. Begin insecticide applications 7–10 days after the first apple maggot fly is caught on a yellow board.

Management notes

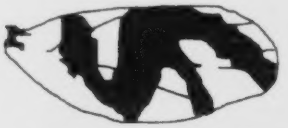
In large orchard blocks, border sprays of the outer 50 m of orchard are effective for managing this pest.

Codling moth

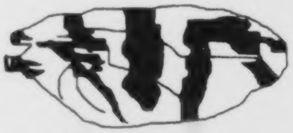
Identification

The codling moth (CM) adult is a small moth (approximately 9 mm in length), grey-brown in colour with white lines on its wings. The larva is light pink with a brown head and measures 10–12 mm at maturity.

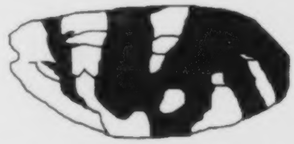
There are 2 types of damage caused by codling moth. As first instar larvae enter the fruit, they create shallow excavated areas below the skin surface known as "stings". These stings create blemishes on the surface of the fruit, but they do not result in interior breakdown of the fruit flesh. The 2nd type of injury is caused when larvae tunnel through the flesh as they move towards the core of the fruit where they feed on the seeds.



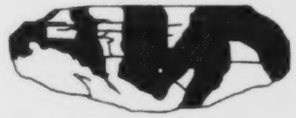
Apple maggot or blueberry maggot fly



Cherry fruit fly



Black cherry fruit fly



Walnut husk fly (eastern)

FIGURE 7–2. Wing patterns of apple maggot and related species

Period of activity

There are 2 generations of CM per year in most regions of Ontario, but only one in the Georgian Bay area. Codling moths begin to emerge in late May or early June. The mature larvae of the 2nd generation are present in the fruit from August through October. Larvae then exit the fruit, crawl under bark scales and create a cocoon to overwinter.

Monitoring and thresholds

Use pheromone traps to monitor codling moth populations. Check traps twice weekly. Thresholds for codling moth are based on degree day models. The first spray for CM is at 100 degree days Celsius

(DDC), base 11°C, after first sustained moth catch. Subsequent sprays can be applied at 14–21 day intervals. Apply for 2nd generation at 700 DDC, base 11°C, after first sustained moth catch.

Dogwood borer

Identification

While there are several types of borers that can potentially attack apples, the dogwood borer is probably or considered to be the most significant. Dogwood borer adults are black and yellow striped clear-wing moths that resemble wasps. Female moths lay their eggs on burr knots and crevices in the lower tree trunk. The larvae tunnel into the burr knots, initially feeding on dead tissue and eventually attacking the cambium. The presence of brown frass on the surface of burr knots is generally a sign of problems with borers.

Period of activity

Dogwood borers overwinter as fully grown larvae underneath bark on the tree; they pupate in the spring. Adults emerge and lay eggs from June until early August.

Monitoring and thresholds

Place pheromone traps in May in orchards with a history of borer problems. Apply an insecticide for control after peak flight.

Management notes

Several management practices can help to reduce problems with dogwood borer. Keep the area around the trunk weed-free, and do not use mulch around the tree trunk. Replace plastic wrap-around or tube-style tree guards with wire mesh guards. This may discourage egg-laying on the tree.

European apple sawfly

Identification

European apple sawfly is a pest of apples in eastern Ontario. The European apple sawfly (EAS) is a clear-winged wasp-like insect. This pest causes 2 types of injury to apple. First instar larvae feed under the skin of the fruit. This feeding causes a heavily russetted, winding ribbon-like scar in the shape of a spiral from the calyx end of the apple. Secondly, as the insect matures it moves towards the seed cavity, often causing the fruit to abort.

Period of activity

EAS adult flight begins during the pink stage of apples and continues through bloom until petal fall. There is 1 generation of European apple sawfly per year.

Monitoring and thresholds

EAS are monitored using 3-dimensional visually-attractive traps consisting of non-UV reflecting white sticky boards that mimic the colour of blossoms. The action threshold for EAS is 6 sawflies per trap if a prebloom insecticide was applied, or 3 sawflies per trap if no prebloom insecticide was applied.

Leafhoppers

Identification

Two species of leafhoppers are important in Ontario apple orchards: white apple leafhopper (WALH) and potato leafhopper (PLH).

The white apple leafhopper overwinters in apple trees. Nymphs are pale white and approximately 1.0–1.5 mm in length. The adults are creamy white, approximately 3 mm in length and hold their wings over their backs when resting.

In contrast, the potato leafhopper does not overwinter in Ontario; adults are transported to Ontario in the spring by wind currents from the southern United States. Nymphs are light green and walk sideways across the leaf when disturbed. The adults are green, with wings that fold like a tent across their back.

Leafhoppers suck sap from the leaves causing stippling or mottling of the leaf. Potato leafhoppers also inject a toxin into the plant while feeding. This toxin blocks the movement of water and nutrients to the affected areas, reducing shoot vigour. Affected leaves turn pale green and curl downward at the margins.

Period of activity

Potato leafhoppers usually migrate into apple orchards in early or mid June, often after the first cut of hay. Multiple generations are active throughout the summer. White apple leafhoppers overwinter in the orchard, and nymphs begin to hatch from bloom through petal fall. There are 2 generations each year, the 2nd in mid-to late August.

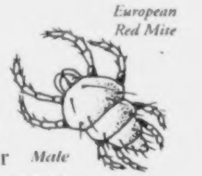
Monitoring and thresholds

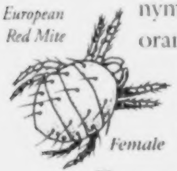
For WALH, randomly select 5 leaves per tree from 20 trees in a block. 1st generation: collect older and middle-aged leaves near the trunk. 2nd generation: randomly collect leaves from arm's length into the tree canopy. Check for white apple leafhoppers on the undersides of the leaves. An insecticide treatment is only necessary when a threshold of 2–5 nymphs per leaf is observed in a 100 leaf sample.

For PLH, examine shoot terminals for leaf curling and other evidence of potato leafhopper damage during regular orchard monitoring. There are no thresholds established for potato leafhoppers in Ontario. However in apples, 1 or 2 nymphs per leaf can cause leaf curling if they are allowed to feed for a prolonged time.

Mites

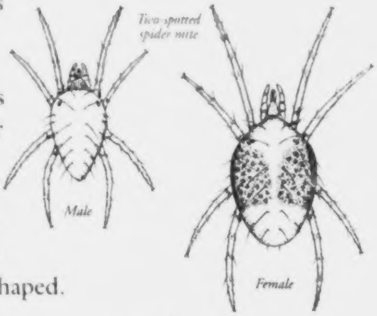
Identification





European red mite (ERM), two-spotted spider mite and apple rust mite are all pests of Ontario apples. These mites are difficult to see with the naked eye, so use a microscope or hand lens to examine leaf samples. ERM nymphs and adult females are dark orange to brown-red in colour. Nymphs have 3 pairs of legs while adults have 4 pairs. Male ERM are smaller than females and are straw coloured.

Two-spotted spider mites (TSSM) are also straw coloured, but can be distinguished from ERM by 2 dark spots on their backs. When populations of TSSM are high, they create a characteristic webbing on the under surface of the leaf.



Apple rust mites occasionally cause problems. Rust mites are much smaller in size than other pest mites, are beige or tan in colour and are carrot-shaped.

All of these mites remove sap, chlorophyll and nitrogen from leaves. High populations of mites can cause "bronzing" of the leaves. Prolonged feeding by high levels of mites in early to mid summer can lead to a reduction in shoot growth and fruit bud set the subsequent year. Fruit size, colour, soluble solids and firmness can also be affected.

Period of activity

ERM overwinter as eggs in the crevices and under scales of the bark. ERM nymphs are present on leaves around tight cluster. TSSM appear later in the season, generally from mid to late summer. By August ERM are beginning to lay overwintering eggs on the calyx end of apples and no longer threaten the crop. In mid to late summer TSSM adults migrate from the tree canopy to weeds on the orchard floor, where they overwinter.

Monitoring and thresholds

Collect 2 leaves from each of 25 trees and count mite eggs, nymphs and adults using a microscope. Note the presence of beneficial mites. In general a ratio of 1 *Amblyseius fallacis* (a predatory mite) for every 10–15 pest mites provides effective biological control.

The economic threshold for mites varies with the time of year. Early in the season when there is little foliage on the trees, thresholds tend to be lower. Later in the season when there is more foliage (and more leaves are available for photosynthesis), the thresholds tend to be higher.

TABLE 7–8. Thresholds for European red mite and two-spotted spider mite on apples

Stage of growth	Spray threshold and timing	Product
Dormant to tight cluster	eggs present	Superior oil
Petal fall to 21 days after calyx	1st egg hatch and before more than 3 nymphs/leaf	Apollo
	5–7 active mites/leaf timed for 50% egg hatch	Agri-Mek and oil
June to mid-July	7–10 active mites/leaf, when approx. 50% of population are nymphs	**Summer miticides:** Pyramite Kelthane 50 W Carzol SP
mid-July to August	10–15 active mites/leaf, when approx. 50% of population are nymphs	**Summer miticides:** Pyramite Kelthane 50 W Carzol SP

Management notes

TSSM is generally more difficult to manage than ERM. Use miticides at the highest labelled rate if necessary. Refer to the pesticide label for details.

The use of pyrethroid insecticides in orchards can cause mite outbreaks. Avoid their use whenever possible. Refer to Table 4–1, ***Insecticide and miticide groups based on sites of action***, on page 46 for a list of insecticides in the pyrethroid family.

Mullein bug

Identification

Mullein bug (MB) nymphs are tiny, oval shaped and translucent. As they mature they become pale greenish in colour. Mullein bug nymphs feed on developing fruit from bloom through petal fall, creating small raised bumps or "stings" on the fruit surface. Fruit that have multiple stings often abort during June drop. Damaged fruit that remains on the tree at this time may develop small corky warts.

Period of activity

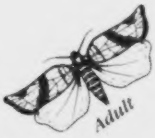
While mullein bugs can be found in orchards from pink until harvest, they only cause damage until 3 weeks after petal fall. Otherwise they are beneficial insects, feeding on aphids and mites.

Monitoring and thresholds

Use a tapping tray to monitor for mullein bugs. Tap 1 limb per tree, on 25 trees per block. Insecticide sprays are recommended in orchards with 7–9 nymphs/ 25 taps.

Obliquebanded leafroller

Identification



Early in the season, overwintering obliquebanded leafroller (OBLR) larvae feed in the developing fruit spurs and leaf terminals. As they feed, they create webbing and roll up in the leaves. These larvae also feed on developing fruitlets creating deep gouges in the fruit. In late summer, feeding by subsequent generations can range from a single small sting to the fruit (pin-prick feeding), to more extensive shallow feeding on the surface of the fruit.

Period of activity

There are 2 generations of OBLR present each year in Ontario. The larvae overwinter in the crevices of the bark and become active from tight cluster to petal fall. These larvae then pupate and the adults emerge in mid June. Summer generation eggs are laid and larvae are active in late June and July. These larvae pupate in August and the moths of the summer generation emerge in late August and early September.

Monitoring and thresholds

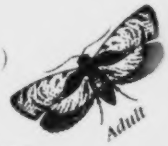
Apply an insecticide when overwintering larvae become active, from pink stage through petal fall. Place pheromone traps in the orchard by June to monitor the overwintering generation adults. Insecticide applications for the summer generation larvae should be applied at 240 DDC after the first sustained moth catch.

Management notes

The insecticides Success 480 SC and the *Bacillus thuringiensis* (B.t.) products, Dipel 2X, Bioprotec CAF and Foray 48 BA have short residual activity. Several sprays may be needed to control the extended emergence of the small larvae. Maintaining the proper pH in the spray solution is important for B.t. products. Use a pH of 7 or less for the spray solution for Dipel 2X, Bioprotect CAF and Foray 48 BA, and a pH of 6 or more for the spray solution for Success 480 SC.

Oriental fruit moth

Identification



Adult oriental fruit moths (OFM) are small, dark grey moths (8–10 mm long) with wavy, light grey bands. Adult females lay eggs on leaves and fruit. Mature larvae have brown head capsules, 3 pairs of legs and distinct pink bodies. OFM larvae look very similar to codling moth (CM) larvae.

OFM larvae attack the terminals and fruit of apples. Frass is present on the terminal and infested shoots wilt. Fruits damaged by CM and OFM have similar symptoms and can be difficult to diagnose correctly. Both codling moth and OFM larvae burrow into the apple, leaving dark frass (fecal matter) at the entry point. OFM larvae most commonly enter fruitlets via the calyx. Late season OFM damage is often difficult to detect and infested apples can make their way through a packing line unnoticed.

Period of activity

OFM adults begin to emerge in late April and this pest continues to be present in apple orchards through October.

Monitoring and thresholds

Currently there are no thresholds for OFM in Ontario apples. In orchards with a history of damage from this pest, monitor populations using pheromone traps.

Management notes

Oriental fruit moth is a pest of apples in southern Ontario (Niagara, Norfolk, Essex, Middlesex). Codling moth damage is similar to OFM damage, so proper identification of the pest is essential for good control. Use pheromone traps to monitor OFM activity.

Currently there are 2 insecticides and 2 mating disruption products registered for managing OFM in apples.

Insecticides: When following an insecticide program, apply sprays 6–10 days after upswing in moth flight for the first generation, and 3–6 days after upswing in moth flight for subsequent generations. For more information on the timing of OFM sprays, contact a crop consultant.

Mating disruption: Apple growers have 2 options when using a mating disruption program to manage OFM. For a season-long mating disruption program apply the pheromones prior to flight of the overwintering generation (generally around half-inch green to tight cluster) and spray supplemental insecticides for emerging larvae. Regional crop and pest reports can help determine the correct timing for pest management decisions, especially in spring when the first pest activity depends on weather conditions.

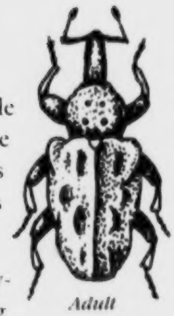
For a partial mating disruption program apply an insecticide to reduce the first generation of OFM populations. Apply mating disruption products for subsequent generations. Be aware of how long the pheromone is effective, since some products may need to be re-applied for season-long control. For more information on mating disruption refer to *Oriental fruit moth* on page 181 and/or OMAF Factsheet *Mating Disruption for Management of Insect Pests,* Order No. 03-079.

Plum curculio

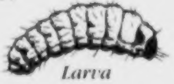
Identification

Plum curculio (PC) is a native beetle and a major pest of pome and stone fruit in Ontario. The adult beetle has brown, grey and white patches on its back, and a large beak-like snout.

Early in the season PC feeds on flowers and developing fruitlets creating small irregular feeding holes. Females lay eggs in developing fruit causing small crescent shaped scars.



Adult



Larva

Period of activity

Plum curculio are first seen in orchards from pink through petal fall. Adults move into the orchard from nearby overwintering sites (brush piles, or leaf debris) after several days of warm temperatures and rain. These insects remain in the orchard until late September. They then migrate out in search of suitable overwintering sites.

Monitoring and thresholds

Traps that attract PC by sight or smell are not effective for evaluating potential damage from this pest. Check fruit on wild fruit trees (plum or apple) near the orchard for PC feeding and oviposition scars from bloom through petal fall. Carefully check for PC damage in trees in orchard border rows near woodlots and wild hosts. Apply an insecticide at first sign of injury.

Management notes

Border sprays are effective in managing this pest, unless there is a history of problems with PC. Refer to OMAF Publication 310, *Integrated Pest Management in Ontario Apple Orchards.*

Spotted tentiform leafminer

Identification

Adult tentiform leafminers (TLM) are small moths approximately 4–5 mm in size, with distinctive patterns of gold, white and black on their wings. Females lay eggs on the lower leaf surface, while emerging larvae mine between the upper and lower leaf surfaces. Early stages of TLM larvae feed only on the leaf juices. As a result their mines are only visible from the underside of the leaf. However, later stages of the insect chew on the leaf tissue and their mines are visible on the upper leaf surface.

Period of activity

Adult moths begin to emerge in late April. There are 3 generations of tentiform leafminers each year in Ontario. The 3rd generation is active in August and into September.

Monitoring and thresholds

Monitor for tentiform leafminer life stages (egg, sap-feeder, tissuefeeder) by collecting fruit spurs and leaves, and calculating the numbers of eggs and larvae per leaf. The thresholds for TLM vary depending on the time of year. (Table 7–9, *Thresholds for tentiform leafminer on apples.*)

Management notes

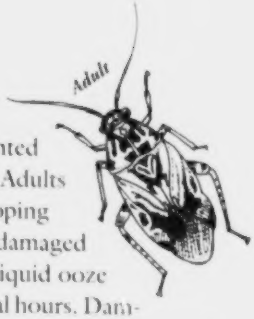
Control of the first generation is more effective than controlling subsequent generations. Control of 3rd generation is discouraged.

TABLE 7–9. Thresholds for tentiform leafminer on apples

Stage of growth	Generation	Threshold
Prebloom or Calyx	1	3 eggs per spur (prior to egg hatch) OR 1 mine/leaf (after egg hatch)
Summer	2	2 mines per leaf (stressed trees) 4 mines per leaf (healthy trees)

Tarnished plant bug

Identification



Adult tarnished plant bugs are 5–6 mm long with segmented antennae and brown bodies. Adults feed on fruit buds and developing flowers and small fruit. Buds damaged by TPB injury exude a clear liquid ooze which turns amber after several hours. Damaged buds do not set properly and are subsequently aborted. Feeding on small fruit causes small surface scars or deep dimples, with a narrow puncture hole in the centre.

Period of activity

Tarnished plant bugs are present in orchards from silver tip through mid June.

Monitoring and thresholds

Monitor flower buds in early spring for indications of adult feeding activity.

Management notes

Injury from this pest is generally low at harvest (0.25%–1%) and insecticide applications aimed specifically at TPB are not cost-effective. Prebloom and petal fall insecticide applications targeted at other early season pests usually suppress tarnished plant bugs.

NOTES ON APPLE DISEASES

Below is an alphabetical list of diseases, except apple scab, which can be found on page 97.

Black rot and frog-eye leaf spot

Identification

Black rot causes many different symptoms in apple orchards. Leaf symptoms are usually called frog-eye leaf spot. First, small purple spots form on the leaves. These spots gradually enlarge, eventually developing into lesions with light tan interior, surrounded by a dark purple perimeter. Heavy infections of frog-eye leaf spot can cause leaves to turn yellow and drop.

Black rot symptoms on tree trunks and limbs appear as cankers, which are reddish brown in colour, and are slightly sunken. As the wood ages it becomes shrunken and layers of bark begin to peel back.

Black rot also causes small purple black spots on the fruit. These spots eventually enlarge forming concentric brown rings.

Period of activity

The heaviest infection occurs during the 4–6 week period following petal fall. However, secondary infections from black rot can occur throughout the summer.

Threshold

There are no thresholds for black rot in Ontario apple orchards. Remove and destroy wood infected with black rot to prevent spread of the disease within the orchard.

Management notes

In orchards where black rot is a problem, avoid using DMI fungicides such as Nova or Nustar for apple scab, because these products do not provide control of black rot. Use a full rate protectant program of Captan or Maestro for several years, as these products also have good activity against black rot.

Blister spot

Identification

Blister spot is a bacterial disease of apples, particularly the cultivar Mutsu (Crispin). Symptoms first appear as small lesions on the lenticels of fruit in mid-to-late July. The lesions continue to expand during the growing season. Near harvest they have blistered brown centres with a dark purple border.

Period of activity

Fruit infection occurs shortly after petal fall. By late July the bacteria can no longer penetrate the cells so infections are less likely to occur.

Threshold

There is no threshold for this disease.

Management notes

Select disease-free nursery stock to reduce problems with this disease. Aliette and copper are effective at reducing the level of infection; however, repeated sprays are necessary.

Be aware of susceptible varieties. See Table 7–14, *Examples of apple cultivars susceptible to key diseases,* on page 102.

Blue mould and grey mould in stored apples

Identification

Blue mould (caused by *Penicillium* spp, especially *Penicillium expansum*) and grey mould (caused by *Botrytis cinerea*) are the principal postharvest diseases of apples in storage.

When apples are infected by blue mould, the rotted areas on the fruit are soft, watery and light brown in colour. Bluish-green spores cover the surface of older lesions. Fortunately, this fungus will not move from an infected fruit to an adjacent fruit unless the fruit is bruised or punctured in some way.

When apples are infected by grey mould, the texture of the decay on the fruit is firm, the skin is tight and tough. The lesions are pale tan to brown and the surfaces of older lesions are covered with greyish mycelium and dark brown spores. Unfortunately, grey mould can move from fruit to fruit, and whole bins or boxes of fruit can become infected.

Period of activity

The apples become infected in the orchard and disease can develop throughout the storage period. Infection occurs at harvest and spores enter primarily through wounds such as stem punctures, bruises and insect injuries. The fungi survive between seasons on contaminated bins and can grow and produce large amounts of spores. These fungi can be transferred from contaminated bins to water used for dipping or drenching as well as grading equipment. Spores can be carried through air currents or by water.

Threshold

There is no economic threshold for these diseases. A single decayed fruit may contain enough spores to contaminate water on the entire packing line.

Management notes

Handle fruit carefully during and after harvest to minimize stem punctures, skin breaks and bruising, which act as infection sites for the fungus. During storage and transportation operators must move the bins with a minimum of jolting and dropping. Refrigerate the fruit as quickly as possible. Adequate refrigeration capacity for each storage room is required. Modern refrigeration facilities and controlled atmospheres also reduce fruit rot.

Sanitation in the handling and grading area is important. Remove rotted fruit from the premises and the property. Change the water used for dipping or drenching frequently.

Postharvest treatment with a fungicide thiabendazole (TBZ) can reduce disease incidence. Mertect SC is registered in Ontario to control the development of blue mould and grey mould on stored apples and pears. Mertect SC can be used as a postharvest dip or drench. Certain precautions must be followed:

- Constant agitation is required to maintain a suspension during treatment.
- Mertect must be in direct contact with the skin of the fruit. Do not apply wax prior to Mertect treatment.
- Consult the label for additional instructions.

Resistant strains of these fungi are common and are not controlled by treatment with thiabendazole. The addition of diphenylamine (DPA) to reduce superficial scald in the postharvest treatment is reported to control some TBZ-resistant strains of penicillium and botrytis. Recently however, these pathogens have also developed resistance to diphenylamine (DPA).

Fire blight

Identification

The bacterium that causes fire blight (*Erwinia amylovora*) attacks the blossoms, shoots, fruit and rootstock of apple trees. Blossom blight develops when warm moist conditions occur during bloom. Blossoms infected with fire blight appear water soaked, and the petals, sepals and receptacle wilt and turn brown or black.

Fire blight affects new shoot growth throughout the spring and summer. Bacteria enter the shoots after they have been damaged by wind, hail or sand. Infected shoots become discoloured and shrivel. Eventually the leaves turn brown or black, and begin to ooze. Infected shoots droop at the tip, creating a symptom often referred to as a shepherd's crook.

Fruit damaged by hail, high wind, rain or insects can readily be infected by *Erwinia amylovora*. Initially infected fruit appears grey, green or water soaked, and eventually the fruit turns dark brown and mummified.

Some rootstocks such as M.9 and M. 26 are susceptible to fire blight infection. Fire blight symptoms in rootstocks are similar to *Phytophthora* collar rot. Infections initially appear dark, water soaked and purplish, with indefinite margins. Later the margins become more definite and are marked by a crack or crevice. Removing the bark under the infected area reveals red-brown streaking in the internal tissues.

Period of activity

Fire blight blossom infections occur during bloom; however shoot infections and trauma blight can occur throughout the growing season. Once terminals have hardened off during the summer they are less susceptible to fire blight infections.

Threshold

Maryblyt and Cougarblight are 2 software programs for determining the need and timing of sprays to control fire blight during bloom. These computer modelling programs predict fire blight infections. They use daily minimum and maximum temperatures, rainfall amounts, leaf wetness (from heavy dew) and weather forecasts to predict the potential of fire blight infection. Advanced warning (1–4 days) of fire blight infection is provided during the critical susceptible growth stages. The most precise prediction for your farm can be obtained by using your own data. Copies of the

Maryblyt program are available from Gary Lightner, 293 Tuscawilla Hills, Charles Town, WV 25414, phone: 540-869-8372, e-mail:*gary.lightner@fisher-sci.com*. For information on Cougarblight, see *www.ncw.wsu.edu/fb2000f.htm*.

Management notes

Streptomycin 17 is registered to control fire blight. The use of Streptomycin 17 is restricted to 10–14 days after petal fall. As a result, cultural management is very important in reducing the incidence of fire blight.

- Avoid excessive amounts of nitrogen fertilizer in the spring. Succulent, rapidly growing shoots and suckers are more susceptible to fire blight infection.
- Remove all diseased wood during the dormant season, (Jan. or Feb.) when temperatures are below freezing.
- Prune new infections at least 30–45 cm below discoloured wood using pruning tools. During growing season leave a stub of wood 2 years old or older, and then prune this stub out during the dormant period. Leaving a stub allows the fire blight to form a localized canker, which the tree can seal off, preventing the infection from extending further into a main limb.
- Disinfect pruning tools between cuts.

Warm temperatures (18°C or greater) and moisture (rain or heavy dew) favour infection of blossoms in spring. When these conditions are predicted, and if they persist through the blossom period, protect the blossoms with Streptomycin 17. Spray during slow drying conditions. Spray is most effective when applied in high volumes of water prior to a wetting period. For best results use Streptomycin 17 alone in the tank.

Streptomycin 17 is sensitive to UV light and is effective for only 2–3 days. If warm, wet weather conditions prevail, 2–4 sprays during the bloom period may be necessary to protect newly opened blossoms. Excessive use of Streptomycin 17 may lead to fire blight resistance.

In non-bearing orchards, copper sprays may be substituted for Streptomycin 17; however, copper is less effective. Mix copper sprays with lime according to label directions. For more information on registered formulations, rates and mixing instructions see *Use of Copper Products on Fruit Crops* on page 54.

Be aware of susceptible varieties. See Table 7–14, *Examples of apple cultivars susceptible to key diseases*, on page 102.

For more information on fire blight refer to OMAF Factsheet *Fire Blight of Apple and Pear in Ontario*, Order No. 02-011.

Flyspeck and sooty blotch (summer diseases)

Identification

Flyspeck and sooty blotch are 2 summer diseases caused by 2 different fungi. Flyspeck, the more common disease, appears as a group of several closely contained small black dots on the surface of the apple. In comparison, sooty blotch appears as a brown-to-olive green, cloudy patch on the surface of the apple skin.

Period of activity

Infections from both of these diseases generally occur around the petal fall stage of apple. However, flyspeck and sooty blotch are considered to be "summer diseases" since their symptoms appear on fruit from mid summer to harvest.

Threshold

No thresholds have been developed for either of these diseases.

Management notes

Flyspeck and sooty blotch can be controlled with most fungicides that are effective for managing apple scab, except Nova and Nustar.

Phytophthora collar rot

Identification

Collar rot occurs where trees are planted in heavy soil, poorly-drained soil or replanted in old orchard sites. This disease, caused by a long-lived, soil-borne fungus *Phytophthora cactorum*, is especially damaging to apple trees grown on MM.106 rootstock. Trees on M.26 and M.111 rootstocks are intermediate in susceptibility, while M.7A and M.9 rootstocks are moderately resistant.

Infected trees have stunted growth, small fruit and yellow leaves, which may turn purple in the spring and fall off. Trees often decline over several years before dying. The wood of crowns of trees infected with

Phytophthora is reddish brown, instead of greenish-white in colour.

Period of activity

Although the fungus is present in many orchard soils, it generally becomes a problem only in low lying areas or poorly drained spots. Infections occur in spring and fall when soils are saturated with water.

Threshold

There is no economic threshold for this pest.

Management notes

Select planting sites and manage water so soil is not saturated for prolonged periods. Wherever possible try to use rootstocks that are resistant to *Phytophthora*. For problem areas, Ridomil Gold 480 EC is registered for use on non-bearing trees only. Apply Ridomil Gold 480 EC as a drench to the soil around the base of the tree. Use 1 mL in 5 L of water/tree. Make the first application at planting and repeat in late August. In subsequent non-bearing years, apply Ridomil Gold 480 EC in the early spring and again in late August. This treatment suppresses fungal growth and development. However, the fungus survives in the soil. Long-term control should include resistant rootstocks and proper site selection.

Powdery mildew

Identification

Powdery mildew is a white, felt-like fungus that covers the leaves and stems of apple terminals. Infected leaves become narrow, folded, discoloured and brittle. During the summer these leaves often turn down and die. A net-like russetting on fruit is sometimes caused by early mildew infection. Powdery mildew can also cause blind wood on apple shoots because infected buds are more susceptible to winter injury.

Period of activity

Powdery mildew first appears on leaves at silver tip, and the disease continues to spread until the terminal buds have set. Powdery mildew tends to be more of a problem during high humidity and temperatures between 18°C–27°C.

Monitoring and thresholds

Use fungicides to prevent powdery mildew before symptoms appear. In orchards with a history of powdery mildew problems, begin a fungicide program as early as half-inch green. Otherwise, sprays for managing powdery mildew are not required until tight cluster. Certain varieties are far more susceptible than others to powdery mildew.

Management notes

Powdery mildew is present in orchards throughout the growing season, but new infections do not occur after shoot growth stops and terminal buds are set. Be aware of susceptible varieties. See Table 7–14, *Examples of apple cultivars susceptible to key diseases,* on page 102.

Apple Scab

Identification

Apple scab, *Venturia inaequalis*, is the most serious fungal disease of apple in Ontario. The fungus attacks foliage, blossoms and fruits by defoliating trees and causing fruit to be unmarketable. In addition to cultivated apple, apple scab also attacks flowering crab apples, mountain ash and firethorn.There are 2 types of apple scab infection. Primary infection is caused by air-borne ascospores that overwinter on infected leaves on the orchard floor. These ascospores infect leaves and developing fruitlets. Lesions caused by primary infection form conidia. These conidia are rain-splashed to new tissue and cause secondary infection.

Primary infection periods

Once apple trees break dormancy and there is green tissue present, a primary infection can occur if the following 3 conditions are met:

- mature ascospores are present
- ascospores are discharged
- moisture is available.

Presence of mature ascospores: Mature ascospores are always present in infected overwintering leaves at bud break. The number of ascospores present depends on the amount of inoculum in the overwintering leaves. The rate at which ascospores mature in the overwintering leaves on the orchard floor is determined mainly by temperature.

Researchers at Cornell University have developed a model relating temperature to spore maturation (expressed in degree days Celsius or DDC). The model allows you to predict the percentage of the season's ascospores that have matured. (See Figure 7–3, *Cumulative percentage of ascospores matured at various degree-day accumulations.*) Daily accumulated degree-days are calculated as follows:

DDC = (Daily max. °C + Daily min. °C) /2 – 0°C

For example, on a day with a high of 10°C and a low of 2°C, the accumulated degree-days is 6 DDC. If either of the daily temperatures are below 0°C, (i.e., a negative number), then use a value of 0 for that temperature. Begin degree-day accumulations at bud break, defined as the day on which at least 50% of the fruit buds on McIntosh are between silver tip and green tip.

Use the degree-day accumulations to estimate the percentage of mature ascospores from the central curve in Figure 7–3. The upper and lower curves are the upper and lower 90% confidence limits around the estimates on the graph. The estimate should fall within this range 90% of the time.

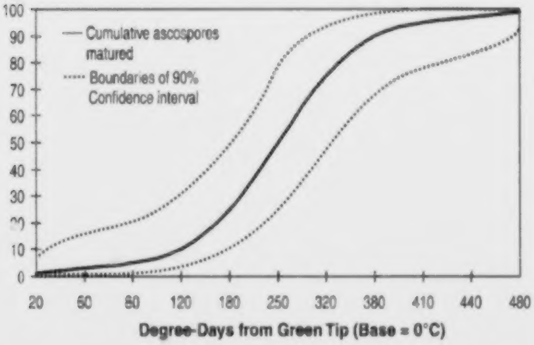


FIGURE 7–3. Cumulative percentage of ascospores matured at various degree-day accumulations

Two points of particular interest on this graph are:

- At 125 DDC — there is a rapid maturation of ascospores indicating a higher risk of infections occurring.
- At 418 DDC — over 95% of the ascospore supply should be depleted if sufficient rain has occurred. (See Table 7–10, *Percentage of mature ascospores discharged under various environmental conditions.*) This marks the end of the primary infection season. With this model, growers can obtain a site-specific forecast of ascospore maturity and discharge for their own orchard(s).

TABLE 7–10. Percentage of mature ascospores discharged under various environmental conditions

Type of rain event	% of mature ascospores discharged
Night rain only	5%
Day rain < 0.25 cm; < 10°C	25%
Day rain > 0.25 cm; < 10°C	50%
Day rain < 0.25 cm; > 10°C	50%
Day rain > 0.25 cm; > 10°C	90%

Ascospore release: Ascospores are released when there is rain to wet the pseudothecia in the dead leaves. Most of the available mature spores are discharged within 2 hours following the start of rain. Ascospore release is strongly light dependent and only a small percentage of available ascospores is released at night (from 7 p.m.– 8 a.m. Eastern Daylight Savings Time [EDST]).

Ascospores are not released to any significant extent during night-time hours in low inoculum orchards. In an orchard where the ascospore inoculum is high, although the percentage of ascospores released is small, the total number of ascospores released is large and can result in a significant primary scab infection.

In a low-inoculum orchard, calculate the length of wetting period using the following method.

- When rain begins during the day, between 8:00 a.m. and 7:00 p.m. EDST, count the hours of leaf wetness from the first hour rain was recorded until the leaves are dry.
- When rain begins at night, between 7:00 p.m. and 8:00 a.m. EDST, count the hours of leaf wetness from 8:00 in the morning until the leaves are dry.

For a high-inoculum orchard, calculate the length of wetting period from the start of the rain until the leaves are dry, regardless of the time of day.

Available moisture: Rainfall is needed for the release of ascospores, and the leaves and fruit must be wet for infection to occur. The length of the wetting period required for infection varies with temperature. This relationship between hours of wetting and temperature is outlined in Table 7–11, *Relationship of temperature and moisture to apple scab infection*, on page 99.

TABLE 7–11. Relationship of temperature and moisture to apple scab infection

Average temp. (°C)	Minimum number of hours of leaf wetness required	
	Primary season (ascospore infection)	Secondary season (conidia infection)
1	40	37
2	34	33
4	27	26
5	21	23
6	18	20
7	15	17
8	13	15
9	12	13
10	11	12
11	9	10
12	8	9
13	8	9
14	7	9
15	7	9
16	6	9
17	6	8
18	6	8
19	6	8
20	6	7
21	6	7
22	6	7
23	6	8
24	6	9
25	8	11
26	11	14

Adapted from: Stensvand, Gadoury, Amundsen, Semb and Seem, 1997 Phytopathology 87: 1046-1053.

Once the length of the wetting period is determined, calculate the average temperature during this interval and check Table 7–11 to see if leaves were wet long enough for an infection to occur.

Secondary infection periods

Secondary scab infections occur when splashing rain spreads conidia, developed from primary scab lesions, on leaves. As with primary infections, secondary infections only occur if moisture from rain is present long enough at a given temperature. Since secondary infections can occur day or night, calculate from the beginning of the wetting period, regardless of time of day. Continued infections through the summer result from lesions caused by conidia.

TABLE 7–12. Relationship of temperature, hours of wetting and weeks after full bloom to secondary apple scab infection of fruit

Average temp. °C	Weeks after full bloom			
	1	5	10	15
	Hours of wetting for 2% fruit infection			
10	13	26	37	45.5
12	10	21.6	31	38
14	8.5	18.5	26.5	32.5
16	7.5	16	23	28.5
18	6.5	14.5	20.5	25.5
20	6	13	18.5	23

Adapted from Schwabe et al., 1984
Cultivars tested were: Golden Delicious, Starking Delicious, Starkrimson Delicious, White Winter Pearmain.

Effect of intermittent rain and dew on infection periods

Periods of dew or high humidity (over 90%) also contribute to a wetting period, but are significant only if preceded by rain. Add together wet periods caused by intermittent rain to determine the length of an infection period, unless wet periods are separated by 10 hours or more of dry, sunny weather.

Fruit infection

As the fruit matures it takes a longer wetting period for infection by apple scab to occur. Table 7–12, *Relationship of temperature, hours of wetting and weeks after full bloom to secondary apple scab infection of fruit*, outlines this relationship.

The wetting periods required for infection of fruit by apple scab are longer than those required for leaf infection. For orchards with only light primary leaf infection and where only fruit scab is of concern, spray decisions may be based on the longer infection times required for fruit. However, if unchecked during the growing season, leaf infection could create large amounts of overwintering scab inoculum and heavy ascospore release the following year.

Management of apple scab with fungicides

Fungicides are used to control scab in most commercial orchards. Table 7–13, *Characteristics of apple scab fungicides*, on page 101, outlines registered fungicides and their effectiveness on scab and other apple diseases.

Here are some definitions of fungicide activity.

- **Protectant activity** — the ability of fungicide residues to inactivate and kill fungal spores, preventing infection.
- **Pre-symptomatic (after infection) activity** — when applied within the period given in Table 7–13, page 101, fungicide prevents scab lesions from developing once the infection has occurred.
- **Post-symptomatic (curative) activity** — fungicide's ability to prevent or greatly inhibit the further production of secondary spores (conidia) when applied to sporulating secondary scab lesions. Generally, applications of fungicides with this activity must be repeated for best effect.

Early season management

Management programs for primary apple scab infection are based on the timing and type of fungicide being used. There are 2 general approaches: apply fungicides on a protectant program before infection occurs or apply fungicides after infection, but before symptoms develop.

Protectant fungicides

Fungicides are applied to expanding foliage before infection periods occur. Apply fungicides when infections are imminent.

- Begin the program just before the first anticipated primary infection period (between silver tip and green tip).
- From first cover until early August, apply fungicides at 10–14 day intervals depending on rainfall frequency. New growth and expanding fruit must be protected and residues washed off by rain must be replaced.
- The exception to this is when using DMI fungicides. Use a 7–10 day spray schedule regardless of rainfall.
- Some fungicides are not readily washed off and the residues are redistributed by rainwater. (See Table 7–13, *Characteristics of apple scab fungicides,* on page 101.)

Pre-symptomatic (after-infection) sprays

An after-infection spray is one applied within a specific time after the start of an infection period. The time available to apply the fungicide effectively depends on the product used and the average temperature. When calculating after-infection activity, start counting the time interval from the beginning of the infection period. For example, at 6°C apply Captan within 48 hours from the beginning of the infection period.

Do not rely on pre-symptomatic (after-infection) fungicide programs to control scab. To use this spray program successfully, equipment capable of providing good spray coverage under adverse conditions is necessary. Reliable and accurate temperature and leaf wetness monitoring equipment for each orchard is essential.

Use of demethylation inhibitor (DMI) fungicides (sterol-inhibitors)

Nova 40 W and Nustar are members of Demethylation Inhibitors (DMIs), a group of fungicides loosely known as sterol inhibitors. These products must be used differently than protectant fungicides such as captan or mancozeb.

The main strength of the DMI group of fungicides is their relatively long post-infection, pre-symptom activity. These products can cure new scab infections if applied within 72–96 hours after infection. The DMI fungicides, however, generally have only 3–5 days of protectant ability.

DMI fungicides must be absorbed by the leaf and fruit tissue to be effective. They are absorbed within 1 hour of application and their effectiveness is not reduced if rain occurs more than 1 hour after application.

DMI fungicides do not redistribute well after application. Therefore uniform spray coverage is essential for good disease control.

Do not use Nova 40 W or Nustar earlier than tight cluster. Apply in combination with a protectant fungicide in blocks of 2 applications, 7–10 days apart. DMI fungicides are weak on fruit scab, so do not start a DMI program after bloom. Apply Nova 40 W, or Nustar plus a protectant fungicide (e.g. Captan), within 72–96 hours following the beginning of a scab infection period. Do not stretch consecutive applications past 10 days. Apply at least 2, but no more than 4 sprays/season, preferably between tight cluster and first summer spray.

After a DMI plus a protectant fungicide application, leaves and fruit are protected for only 5 days. Apply a protectant fungicide before the next scab infection period. Follow up with a protectant fungicide program as required for the rest of the season.

TABLE 7–13. Characteristics of apple scab fungicides

Product/1,000 L	Protectant activity (pre-infection)	Max. after-infection[1] activity (hr)			Post-symptom activity	Retention (50 mm rain)	Re-distribution (12 mm rain)
		6°C	12°C	17°C			
Captan 50 WP (2 kg)	VG	48	24	18	N	VG	G
Dikar WP (2 kg)	VG?	48	24	18	VG	E?	VG?
Dithane M 45/80 WP (2 kg)	VG	48	24	18	N	E	VG
Equal 65 WP (0.5 kg)	VG	48	24	18	VG	VG	VG
Flint 50 WG	E	96[3]	96[3]	96[3]	E	E	F?
Manzate 200 (2 kg)	VG	48	24	18	N	E?	VG
Nova 40 W (140 g)[2]	F	96	96	96	FG	F?	F?
Polyram 80 WP (2 kg)	VG	48	24	18	N	E?	VG
Nustar	F	96	96	96	E	E	
Sovran	E	96[3]	96[3]	96[3]	E	E	F?

Data is adapted from New York (Geneva) from work done by Szkolink et al. using conidia. These values are adapted from greenhouse tests on Golden Delicious. Rate/ha is 3 times rate/1,000 L. The after-infection activity of these fungicides may not be adequate to control primary scab in commercial orchards. Do not rely solely on after-infection activity for the control of apple scab.

These results are formulation specific. Newer formulations of some products have not been evaluated (e.g., Dithane DG, Polyram DF, Manzate 200DF). Contact the manufacturer for more information.

[1] Maximum after-infection activity is calculated from the start of the infection period.

[2] Data on Nova is adapted from *1993 Pest Management Recommendations for Commercial Tree Fruit Production*, Cornell Cooperative Extension, New York.

[3] After-infection activity may be reduced in orchards where scab populations have shifted toward resistance to DMI fungicides (Nova, Nustar).

KEY: E = excellent; VG = very good; G = good; F = fair; P = poor; N = none. Values followed by (?) are based on field observations.

Resistance has developed to DMI fungicides in other countries, where multiple applications were made each season for several years. To minimize or delay the development of DMI-resistant apple scab in Ontario orchards:

- mix these products with a protectant fungicide (e.g., mancozeb or captan)
- limit the number of applications to no more than 4 times per season
- do not use when scab lesions are present, because this may encourage the development of DMI-resistant strains of scab.
- Do not alternate between Nova 40 W and Nustar because these products have similar modes of action.

Do not apply sterol-inhibiting (DMI) fungicides when scab lesions are present because this encourages resistance to develop.

Use of strobilurin fungicides

Sovran and Flint 50 WG are members of a new family of fungicides called strobilurins. These products have good protectant, post-infection and antisporulant activity on apple scab and powdery mildew. Do not use Sovran or Flint 50 WG earlier than tight cluster and apply in blocks of 2 applications, 10 days apart. Due to of the mode of action, it is important to follow resistance management strategies carefully. Use another chemical family for 2 applications before returning to either Sovran or Flint 50 WG. After applying Sovran or Flint 50 WG, tissue is protected from infection for 5–8 days. In conditions of rapid growth, shorten intervals between applications.

Some strobilurin fungicides are phytotoxic to other fruit crops (i.e. Sovran: sweet cherries; Flint: concord grapes.) Always check the label for precautions.

Control of apple scab under adverse weather conditions

Several consecutive days of continuous wet conditions and mild temperatures are common in the spring. These conditions encourage apple scab infection. It is often difficult to maintain sufficient fungicide on the trees to provide protection for the rapidly expanding foliage and fruit under such conditions.

If there is concern about adequate protection, it is better to apply a protectant-type fungicide during a break in the rain, than to not spray at all. Be sure to use a fungicide with good retention properties. For example, products with mancozeb such as Dithane, Manzate and Penncozeb have good retention activity.

After-infection sprays may be required when protectant fungicides become too diluted to prevent the apple scab fungus from establishing itself on the foliage or fruit.

If an infection exists, scab lesions become visible on the foliage and fruit in about 9 days at 20°C, or in about 14–21 days if the average temperatures are 12°C or lower. Control these infections as soon as they become visible by following the instructions outlined in the section below on *Deactivation of established scab lesions.*

Strong winds can hamper spraying operations by causing pesticides to drift away from the intended target. Spray at night or early morning to help reduce spray drift. Lowering the spray trajectory into the wind may also help, but take extra care to ensure the treetops get good spray coverage.

Deactivation of established scab lesions

Apple scab lesions visible on the foliage and fruit can produce many spores capable of spreading the disease through secondary infection. Several fungicides have good post-symptomatic activity (see Table 7–13). Continuous use of these fungicides as eradicants promotes resistance. For example, thiophanate-methyl (Senator) and dodine (Equal) have lost effectiveness against apple scab because resistance to these fungicides has developed in Ontario orchards.

If fungicide-resistant scab is not present in your orchard and apple scab lesions are visible, try to deactivate these tissue infections. Apply 2 sprays of a post-symptomatic fungicide at the full rate 5–7 days apart **as soon as** scab lesions are observed. These materials reduce the number of spores produced on the lesions and help to slow the spread of the disease. Follow with a regular season-long protectant program.

Secondary scab management

The end of primary season can be determined by using the degree-day model. At 418 DDC, over 95% of the ascospores are mature and after a significant rain all of the ascospores have been discharged for the season. (See Table 7–10 on page 98.) After this point, wait 2 weeks then check the trees for scab. It can take up to 14 days for lesions to appear following a scab infection period. Be sure to check the top of standard trees or anywhere else where spray coverage may not have been adequate, e.g., thick tree canopy.

If primary scab was controlled, the rates of fungicides may be reduced and the interval between sprays may be lengthened for the remainder of the growing season. Some growers have successfully eliminated all use of fungicides during the summer months where primary scab was controlled. If scab lesions are found, maintain a fungicide program for the remainder of the season.

TABLE 7–14. Examples of apple cultivars susceptible to key diseases

	Very susceptible	**Least susceptible**
Apple scab	McIntosh, Cameo, Sunrise, Shizuka, Gala and Golden Supreme, Cortland	Pristine, Enterprise, GoldRush
Fire blight	Fuji, Gala, Ginger Gold, Idared, Jonagold	Red Delicious, Liberty, Enterprise, Freedom
Powdery mildew	Cortland, Idared, Paulared	Red Delicious, McIntosh, Empire, Northern Spy, Freedom, Jonafree
Blister spot	Mutsu, Golden Delicious, Red Delicious, Jonagold, Cortland	all others

TABLE 7–15. Effect of fungicides on apple diseases

Use fungicides only for control of diseases listed on the product label.

Fungicides	Apple scab	Powdery mildew	Cedar apple rust/quince rust	Black rot	Bitter rot	Sooty blotch	Fly speck
captan (Supra Captan 80 WDG, Maestro 80 DF)	+++	0	0	+++	++	+++	++
copper	+	+	+	+	+	+P	+P
cyprodinil (Vangard 75 WG)	++	+	0	0	NA	0	0
dithane+ karathane (Dikar)	+++	+++	++	+	NA	+++	+++
flusilazole (Nustar)	+++	++	+++	0	0	0	0
kresoxim-methyl (Sovran)	+++	++	+	+++	++	+++	+++
mancozeb (Dithane DG, Manzate 200 DF, Penncozeb 75 DF)	+++	0	++	0	NA	+++	+++
metiram (Polyram DF)	+++	0	++	0	NA	+++	+++
myclobutanil (Nova 40W)	++	+++	+++	+	0	0	0
sulphur	+	++	+	0	0	0	+
trifloxystrobin (Flint 50 WG)	+++	++	+	+++	++	+++	+++

P = Phytotoxic, causes russetting.
0 = no control.
NA = not applicable because the fungicide cannot be applied during late summer when bitter rot infections usually occur.
+ = poor to fair control, ++ = good control, some limitations, +++ = excellent control, few if any limitations, ? = efficacy unknown.
This table was developed by the IR4 Project through discussion at the annual meeting of the Deciduous Tree Fruit Diseases Workers in August, 1999 and updated by McSmith Research Services.

THINNING AND GROWTH REGULATORS

Chemical Thinning of Apples

Thinning of apples is required:

- to improve overall fruit size and finish
- to create more uniformity in the crop
- to encourage return bloom and annual bearing.

The objective of thinning is to reduce clusters to single fruitlets (preferably the king bloom fruitlet) and to adequately space fruit to every other bearing spur.

The earlier thinning is accomplished after bloom, the greater the potential for increasing average fruit size and maximizing return bloom the following year.

Thinning needs are based on grower experience. The previous thinning history should be well documented. Other factors include:

- the cultivars involved
- fruit sizes required
- strength of bloom
- bee activity
- weather conditions during pollination.

Compared to a tree with an excessive crop load, a well-thinned crop has better colour, and is more efficient to harvest — translating into lower labour costs per bin at harvest.

Fruit Size Distribution in the Tree Canopy

When comparing a well thinned apple tree, of any cultivar, to a tree that is insufficiently thinned, several factors become obvious.

Size distribution of fruit within the canopy of both trees follows a normal distribution pattern. See Figure 7–4, *Fruit size distribution in the canopy of a thinned Empire tree compared to an unthinned control.*

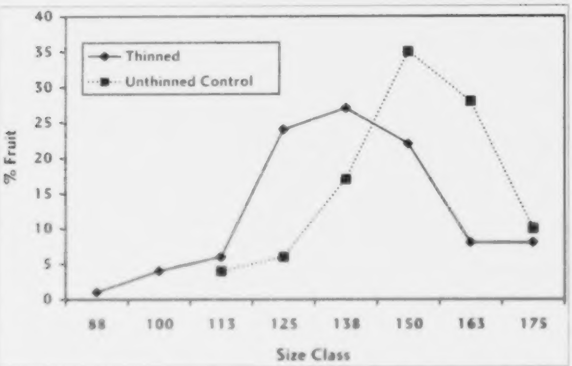


FIGURE 7–4. **Fruit size distribution in the canopy of a thinned Empire tree compared to an unthinned control.** (Total yield differences by weight between the two trees was within 10%)

Other factors being equal, the average fruit size from the thinned tree is greater than that of an unthinned tree.

While adequate thinning typically reduces yield, the value of the thinned crop more than compensates for any loss in yield, provided the tree is not overthinned.

In other words, where the fruit volume of thinned and unthinned trees is similar, the thinned tree has fewer apples, but they are of greater size and higher value. See Table 7–16, *Tray pack size of apples in relation to number of apples per bin and per tree,* on page 105 for a comparison of fruit numbers of different size classes required to fill a standard apple bin.

Chemicals Available for Thinning

Accel

Accel is an altered form of Promalin. It contains the growth regulator benzyladenine (BA), which is the active ingredient for thinning, and gibberellin A_{4+7}. Accel is registered for use in Canada at the rate of 2.5–4.0 L/ha, which is equivalent to 49–74 g BA/ha. The use of Accel is limited to 2 sprays per season, each containing no more than 74 g BA/ha. Since the label is based on product/ha, the maximum concentration applied depends on tree size and volume of water used to obtain good coverage. Research at the Simcoe Horticultural Experiment Station and elsewhere indicates that the concentration of BA in the spray solution is also important. Concentrations below 50 ppm BA are generally ineffective for thinning or improving fruit size.

Accel is not a satisfactory thinning compound for all cultivars but has exhibited effectiveness for Empire, McIntosh, Idared, Gala and others. See Table 7–19, *Suggested rates for chemical thinning of mature apple trees,* page 110.

Unlike other chemical thinners currently available in Canada (NAA and carbaryl), Accel has the potential to improve fruit size independent of thinning. Accel causes increased cell division shortly after flowering during the early stages of fruit growth and development, and this translates into larger fruit at harvest.

The window of best response for Accel is between 5–12 mm fruitlet size. Dilute Accel in 500–1,000 L of spray solution/ha. Uniform and thorough coverage is essential.

Environmental conditions

To optimize plant uptake of the spray solution, apply Accel during periods of slow drying (for example, early morning). Best results are obtained when warm temperatures (greater than 20° C) occur during and following application. Always read the label before using.

Spray concentration

First, determine the concentration of BA to use. Secondly, determine the water volume required to wet the foliage just to the point of runoff. Then, use Table 7–17, *Accel rate,* on page 106 to determine the volume of Accel to add to deliver the correct amount of BA in the correct concentration to be effective.

NAD (naphthaleneacetamide)

NAD, such as AMID THIN, is a hormone-type material that is absorbed by foliage, where it induces formation of the abscission layer between the spur and the fruitlet. NAD is a relatively safe material. Apply NAD at first petal fall; i.e. when petals on the king blossom are falling. Use concentrations of 50–100 ppm, depending on variety and growing conditions. NAD is particularly effective on hard to thin varieties such as Golden Delicious, if used at the proper timing. NAD is mostly absorbed from the original solution. Once dry, the effect it has on thinning is over. Therefore use large water volumes applied under slow drying conditions. Weather that promotes soft, succulent and rapid growth leads to increased absorption. Avoid windy, cool, fast drying conditions. Temperatures between 21°C–24°C are considered optimum.

TABLE 7–16. Tray pack size of apples in relation to number of apples per bin and per tree

					Number of apples required per tree for given tree density, desired yield and fruit size						
					Tree density (trees/acre)[3]						
				Number of apples required to fill bin[2]	272		500		1,000		
	Minimum size				Projected yield (Bu/ac)						
Tray Size	wt (g)[1]	in	mm		400	600	500	750	750	1250	
196	102	2 1/4	57	3,920	320	480	218	327	163	272	Juice
175	114	2 3/8	60	3,500	286	429	194	292	146	243	
163	123	2 1/2	64	3,260	266	400	181	272	136	226	Target
150	133	2 5/8	67	3,000	245	368	167	250	125	208	
138	145	2 3/4	70	2,760	225	338	153	230	115	192	
125	160	2 7/8	73	2,500	204	306	139	208	104	174	
113	177	3	76	2,260	185	277	126	188	94	157	
100	200	3 1/8	79	2,000	163	245	111	167	83	139	
88	227	3 1/4	83	1,760	144	216	98	147	73	122	
80	250	3 3/8	85	1,600	131	196	89	133	67	111	
72	278	3 1/2	89	1,440	118	176	80	120	60	100	
64	313	3 5/8	92	1,280	105	157	71	107	53	89	
56	357	3 3/4	95	1,120	92	137	62	93	47	78	
48	417	3 7/8	98	960	78	118	53	80	40	67	

[1] These values are approximate as fruit of the same diameter can differ in weight.

[2] 18 bushel bin capacity.

[3] Trees spaced at approximately 10 ft. x 16 ft. (272 trees/acre; free standing central leader), 6.5 ft. x 13 ft. (500 trees/acre; spindle type system) and 3.5 ft. x 12 ft. (1,000 trees/acre; super spindle).

NAA (naphthaleneacetic acid)

NAA, such as FRUITONE-N, is a hormone-type thinner that is absorbed primarily through the leaves. NAA affects auxin activity and interferes with proper fruit development by accelerating ethylene biosynthesis. The fruitlet being thinned usually drops within 10–14 days after spraying. Plants absorb NAA only when it is dissolved in water. Almost all NAA is absorbed from the original solution. Once dry, the thinning effect is stopped. Therefore, use larger volumes of water under slow drying conditions. The longer the time required to dry the spray and the higher the drying temperatures, the greater the absorption of the NAA. NAA has a short life due to breakdown by sunlight. The most effective time to spray is under warm, dull, slow drying conditions. The preferred time is in the morning when the trees are damp, drying is slow, and the temperature is on the rise. The material is absorbed and the tree has an immediate growing day to use the thinner. NAA is considered to be rain fast after 2–3 hours. NAA is not effective at temperatures less than 10°C. NAA can result in leaf flagging (wilting) but these leaves recover in a few days.

PRECAUTIONS

Do not apply Accel in combination with the hormone thinners NAA (naphthaleneacetic acid) or NAD (naphthaleneacetamide) either as a tank-mix or separate sprays during the same growing season. Doing so may result in pygmy fruit.

Carbaryl (Sevin)

Carbaryl is the active ingredient in the insecticide Sevin. Carbaryl is absorbed primarily through the fruit, not the foliage. The presence of carbaryl in the vascular system of the fruitlet interferes with biochemical processes. Certain important fruit growth processes cease, and the fruitlet drops. This fruitlet drop usually starts 5–10 days after application. Thinning with Sevin increases with increasing concentrations up to 1.0 kg active carbaryl (2.0 L Sevin XLR Plus)/1,000 L of water. There may be little or no increase in thinning with higher concentrations. Carbaryl is relatively insoluble in water and low

TABLE 7–17. Accel rate

The relationship between spray water volumes required to thoroughly wet trees, grams active ingredient (BA) per hectare, and concentration of BA and per hectare rate of Accel.

	grams BA per hectare				
	25	37	49	62	74
	litres of Accel per hectare				
Spray volume required to thoroughly wet trees (litres/ha)	1.3	2.0	2.6	3.3	3.9
	Concentration of BA in parts per million (ppm)				
200	124	185	247	309	371
300	82	124	165	206	247
400	62	93	124	154	185
500	49	74	99	124	148
600	41	62	82	103	124
700	35	53	71	88	106
800	31	46	62	77	93
900	27	41	55	69	82
1,000	25	37	49	62	74

Concentrations of BA in shaded area not recommended.

concentrations produce a saturated solution. This insolubility limits its effectiveness because absorption by the fruitlet is restricted to materials in true solution. It is an advantage however, because the hazard of over thinning through concentration errors is reduced. Surface residues of the XLR Plus formulation of Sevin (unlike the 50 W formulation) do not provide additional thinning effects when rain or dews cause re-wetting of the tree canopy. Sevin, although the easiest and safest thinner to use can, depending on the amounts used, be harsh on beneficial insects and mite predators.

1 L of Sevin XLR Plus contains approximately the same amount of active ingredient (carbaryl) as 1 kg of Sevin 50 W.

Carbaryl (Sevin) plus NAA

This combination has been used successfully on hard-to-thin cultivars such as Paulared, Golden Delicious, Fuji and Gala strains. Use a constant rate of 1 L Sevin XLR Plus (product)/1,000 L of water with varying rates of NAA from 3–15 ppm. Because NAA only has 1 chance to work, use high water volumes.

BEE WARNING

When Sevin is used in fruit thinning, extensive bee kills can occur if weeds or legumes are blooming in the ground cover. To reduce the chance of poisoning, remove bees from the orchard prior to treatment. Do not spray when the wind will carry Sevin to adjacent weedy or crop areas in bloom. Sevin XLR Plus is much safer to use than Sevin 50 W around honeybees. Advise local beekeepers of your spraying activity.

Factors Influencing Response to Thinning Agents

Length of wetting period and temperature for material absorption

Plants absorb thinning materials more quickly at higher temperatures than lower ones. Best temperatures for absorption are in the 20°C–25°C range. At these temperatures, drying time is usually much faster than early morning or evening when temperatures are 10°C–15°C cooler. Absorption under cooler conditions appears to be slower and stretches over a longer period or until the canopy dries.

The total amount of thinning chemical absorbed by the tree canopy appears to be more or less equal regardless of drying time (warm and fast, or cool and slower).

Time of day is not a critical factor from a drying perspective. Research on selected cultivars indicate no differences in success based on timing of sprays during day or night. However spraying in early morning or evening reduces the likelihood of blowing thinners off target. Wind can become more of a factor during the day.

Cultivar sensitivity (mature trees)

Easy-to-thin cultivars include non-spur Red Delicious, Idared, Crispin (Mutsu), Jonagold strains, Jerseymac, Honeycrisp.

Moderately difficult cultivars include Empire, McIntosh, Northern Spy, Cortland and Gingergold.

Harder-to-thin cultivars include Golden Delicious, Paulared, Gala strains, Fuji, Spartan, Wealthy, spur-type McIntosh and spur-type Red Delicious.

Weather conditions

The following weather conditions may increase the thinning response by permitting greater absorption of chemicals:

- cool, wet weather and low-light conditions before or after application
- prolonged period of high humidity without rain either before or after application
- high temperatures following cool periods
- frost or near-freezing temperatures before or shortly after application
- a prolonged period of dry weather before application.

A decrease in thinning response can result from the following condition, which results in a high net accumulation of carbohydrate reserves in the tree:

- sunny and warm daytime temperatures accompanied by relatively cool nighttime temperatures before and after thinning treatments have been applied.

Pollination and bee activity

These activities are closely tied with weather conditions. Pollinating conditions and bee populations may render fruit either more or less difficult to thin. Fruit set under good pollinating conditions, resulting in increased seed count, is harder to thin. Fruit set on king blossoms is more difficult to thin than fruit set on side blossoms. Single fruit are more difficult to thin than clustered fruit. A light or spotty set, with clustered fruit, should be thinned, but at low rates in order to break up the clusters.

Tree age and vigour

- Young trees are more easily thinned than mature trees that have cropped well for 2–3 years. Hand thin young trees of high-value cultivars that do not have a settled cropping pattern. Low rates of thinners that work on mature trees can easily over-thin young trees.
- Mature trees that are low in vigour, for whatever reason, are more easily thinned.
- Trees bearing a heavy crop one year with good bloom the following year may be more easily thinned.
- The heavier the bloom, the more stress on the tree, and the easier to thin.
- The more stress from the previous season — e.g. excessively dry or excessively wet, nutritional deficiencies, insects or disease — the easier to thin.

Density of foliage

- Poorly-pruned dense trees are thinned more easily than well-pruned open trees.
- Lower, partially shaded, branches of well-pruned trees are thinned more easily than upper branches because of weaker spurs.
- If thinning is delayed significantly, increase water volumes to ensure adequate coverage of the rapidly developing tree canopy and leaf surface area during the fruit set period.

Timing of Application

- Application timing varies with the chemical used.
- Apply NAD during early petal fall (see *NAD (naphthaleneacetamide)* on page 104).
- The best timing for applying NAA, Sevin and NAA + Sevin combinations is usually 7–12 days after petal fall[1]. (Early cultivars are an exception, see Table 7–19, *Suggested rates for chemical thinning of mature apple trees1*, on page 110.) Use 7 days if it is warm and 12 days if it is cool.

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[1] Petal fall — when 80% of the petals have fallen off but before calyx lobes are closed.

- Sevin can be effective as a thinner when applied up to 21 days after petal fall.
- NAA is only effective if applied up to 12 days after petal fall. NAA applied too soon (bloom to petal fall period) can result in excessive thinning of Empire.

For some cultivars, apply chemical thinners based on the average fruitlet diameter. (See Table 7–18, *Suggested timing of thinning (NAA)*.) When the largest fruitlets (preferably the king bloom fruitlet) have reached the stated diameter, if the thinner is effective the smaller and weaker fruitlets should drop off. This relationship works best when the king bloom fruitlet is larger than the side bloom fruitlets and when the size and stage of development of all fruit to be thinned is fairly uniform.

TABLE 7–18. **Suggested timing of thinning (NAA)**

Cultivar	Diameter of largest fruitlets in cluster
McIntosh	8.0–9.5 mm
Red Delicious	6.5–8.0 mm
Northern Spy	10.0–11.0 mm
Empire, Idared, Jonagold	8.0–10.0 mm
Gala, Golden Delicious, Fuji	8.0–9.0 mm

Sampling method to determine timing

Collect 50–60 fruitlets of each cultivar to provide a good estimate of fruit development in a reasonably uniform orchard block. Select the 2 largest developing fruits from each of 25–30 randomly selected clusters. Measure the greatest diameter of each and determine the average for the sample. Vernier calipers or a thinning template provide a simple means for taking measurements rapidly and accurately.

Steps in Thinning

1. Determine how much thinning is required by looking at the orchard factors and assessing fruit load potential. Sepals (calyx leaves) on unpollinated bloom tend to stay open or bend back. Successful pollination and fruit set results in sepal movement and closure.
2. Determine the material to use and the concentration or strength of the thinner required.
3. Determine the water volume required to effectively wet the trees. Dilute water volumes are recommended when applying chemical thinners. The average tree on M26 (3–3.5 m tall) at a density of 720 trees/ha (300/ac) may require more than 2 L of spray/tree to thoroughly wet it at the time of thinning. As the tree size becomes smaller and the number of trees/ha increases, the volume of canopy that must be sprayed may become less. The "tree row volume" concept is an accepted way to calculate required water volumes. See OMAF Factsheet, *Guide for Spraying Tree Fruits*, Order No. 00-035. Calibrate the sprayer and water volumes on small groups of trees to determine just how much water is required to thoroughly wet individual trees.

Special Conditions

Thinning after a badly-frosted bloom

Depending on the severity of the damage, growers may thin sections or areas of the orchard that appear to have escaped the worst of the frost damage. Differences in elevation and airflow in the orchard can lead to great variations in frost damage to tree foliage and potential fruit set. Trees in the same block but on lower ground can be exposed to air 2°C–3°C colder than trees on higher ground in the same frost event.

In making a decision to apply thinners, the grower may plan to spray some of the block because of what appears to be a fairly normal set on trees on higher ground. Nozzles can be shut off in areas of the block that are showing significant potential losses in crop load from frost. Likewise, nozzles directing thinning sprays into the lower canopy can be shut off if necessary.

Carefully evaluate damage to the bloom. Petals, stamens, pistils and ovaries can exhibit a significant difference in their response to freezing temperatures. (See Figure 7–5, *Anatomy of an apple bloom*, on page 109.) Although flower petals are browned off by frost, the process of set can still take place from pollination that occurred 1–2 days before the frost event.

Frost around bloom usually produces a variety of symptoms. Bands of russetting that run either around the fruitlet (frost rings) or lengthways, from stem to calyx, are a symptom of frost damage. Frost can also reduce seed count and result in a high proportion of misshapen fruit at harvest.

Exercise extreme caution when thinning after a significant frost. Leaves damaged by frost absorb more of the thinner. Fruitlets with reduced seed count abscise more easily. Consider applying lower rates of thinner for many varieties under these circumstances. Or, on a badly damaged block, do not apply a thinner but rely on hand thinning if necessary. However, a light amount of frost damage should not prevent the use of thinning treatments that worked in the past for any given cultivar.

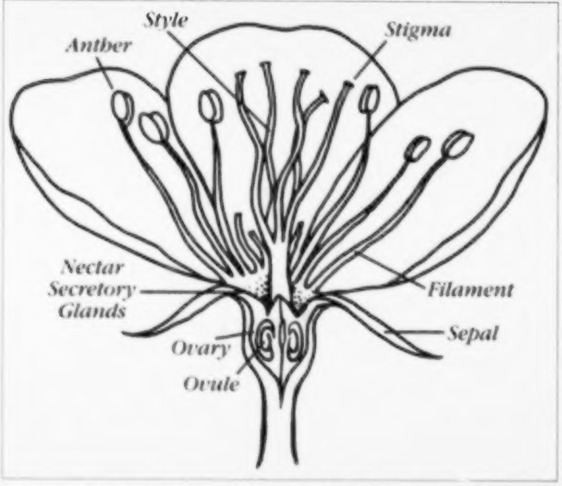

FIGURE 7-5. Anatomy of an apple bloom

Thinning when the king bloom is lost to frost

Response to thinning treatments is generally based on size and dominance differences within the cluster of set fruitlets. The king fruitlet of most cultivars is usually larger, stronger and more dominant than side-bloom fruitlets. (An exception is Paulared). The king will normally hold on when weaker, smaller fruitlets drop in response to treatments.

If the king bloom or king fruitlet is lost to frost, size and strength differences amongst remaining fruitlets can be minimal, making them equally weak and vulnerable to thinners. The best approach in this case may be to wait until size differences appear in the cluster (provided the largest fruitlet is not greater than 12–14 mm). These size differences may become more apparent several days past full bloom. A difference of a few hours in pollination timing can show up in size differences of side-bloom fruitlets as the post-bloom period progresses.

Thinning when weather conditions are poor

Weather conditions are often not suitable for applying thinners even though the fruitlet diameter is at the recommended stage of development. Poor conditions can include cold, wet, windy or rainy weather that can persist for days at a time. Growers are better off waiting for warmer temperatures, more sunlight and less wind, even though the fruitlet diameter could be larger than the diameter suggested for application of thinners. Thinners applied when king fruitlets are 12–14 mm in diameter will give a better response under warmer conditions than thinners applied to king fruitlets at 8–10 mm in persistent cold, wet and rainy conditions. Warmer temperatures include temperatures at or above 18°C during the day of application or for 24 hours after spraying.

Thinning an unevenly set crop

In most cases apply thinners even when the crop is unevenly set. Single fruitlets are much tougher to remove from the canopy. These fruitlets can be present at the same time as multiple-set clusters in the same tree or block. In comparison, fruitlets found in clusters of 3–5 are easier to thin because of competition within the group. Ultimately, only 5%–10% of the bloom, in any cultivar, produces a commercial crop of fruit. Therefore in situations of uneven set on unstressed trees and in the absence of frost injury, follow the recommended thinning treatments.

Cultivar Notes

Empire

Before applying NAA, make sure the king bloom fruitlet is set by checking sepal posture. Petal fall of king bloom can take place as early as 3–4 days past peak pollination. If NAA is used too early (full bloom to petal fall), the overall fruit size of unthinned apples may be reduced compared to treatment at a stage when the king fruitlet is 8–10 mm in diameter.

Gala

Gala is relatively difficult to thin successfully. On mature trees, the approach must be aggressive. Good results have been achieved using a combination of NAA and Sevin at the rates listed for Golden Delicious. The suggested timing for this application is when king fruitlets are at 8–9 mm. Fruit size potential is determined within 2 weeks following calyx. Clusters must be thinned to 1 fruitlet (king bloom) by mid to late June. A follow-up hand thinning within 30 days of full bloom is normally required to further reduce crop load.

TABLE 7–19. **Suggested rates for chemical thinning of mature apple trees**[1]

use ONE of the following:

Cultivar	NAD ppm[2]	NAA ppm[2]	Sevin XLR Plus[2] L/1,000 L	Sevin XLR Plus +NAA ppm[2] per 1,000 L water	Accel (g BA/ha)[3]	Sevin XLR Plus (L/1,000 L water)[2] + Accel (g BA/ha)[3]
Lodi, Melba, Quinte, Yellow Transparent	50–75	—	—	1 L + 10–15 ppm	—	—
Early McIntosh	75–100	—	—	1 L + 5–10 ppm (at petal fall)	50–75	—
Jerseymac, VistaBella, Tydeman's Red	—	5–10	1–1.5	—	—	—
Paulared	50–75	12–15	1.0–1.5	1 L + 10–15 ppm	75	1 L + 50
Spartan, Russets		10–20	1.0–2.0	1 L + 10–15 ppm	—	—
Cortland	—	5–10	—	1–2 L + 2.5–5 ppm	—	—
Non-spur McIntosh	—	5–10	1.0–2.0	—	50	—
Spur-type McIntosh	—	10–12	—	1–2 L + 2.5–5 ppm	50–75	1 L + 50
Golden Delicious, Wealthy	75–100	10–20	1.0–2.0	1 L + 5–10 ppm	75	1–2 L + 50
Red Delicious	—	2–8	0.5–1.5	—	—	—
Spur-type Red Delicious	—	5–10	—	1–2 L + 5–10 ppm	—	—
Idared	—	2–8	—	—	50	—
Empire	—	7–10	1.0–1.5	1 L + 2.5–4 ppm	50–75	1 L + 50
Spy, Crispin (Mutsu)	—	5–10	0.5–1.5	—	—	—
Jonagold	—	—	1.0–1.5	—	50–75	—
Fuji	—	—	—	1–1.5 L + 10–12 ppm	—	1–2 L + 50–75
Gala	—	10–12	—	1 L + 5–10 ppm	75	1–2 L + 50
Honeycrisp	—	5	1–1.5	1 L + 2.5 ppm	—	—
Gingergold	—	7–10	1–1.5	1 L + 2.5–5 ppm	—	1 L + 50

"—" indicates treatment recommendation not available

[1] The above rates are suggested for trees with a settled cropping history. To chemically thin a first crop tree or trees considered to be immature is very risky.

[2] Sufficient water volume must be used to thoroughly wet trees. See *Steps in Thinning* on page 108.

[3] Consult Table 7–17, *Accel rate*, on page 106, to determine the actual ppm benzyladenine (BA) being applied. Concentration of BA should be no less than 50 ppm to be effective. 1 L of Accel contains approx. 19 grams of BA.

Note: The rates for Sevin are amounts of product. Sevin XLR Plus is 43% active ingredient and contains 480 g or approximately 0.5 kg of carbaryl/litre. One litre of Sevin XLR Plus is roughly equivalent to 1 kg of Sevin 50 W. For actual amounts of NAD and NAA refer to the label of the product being used.

Jonagold

This cultivar thins relatively easily and has good size potential when clusters are thinned to singles. Most producers get adequate thinning with moderate rates of Sevin. Overcropping of Jonagold may result in very poor return bloom and fruit may not mature to a premium quality.

Fuji

Unthinned Fuji normally returns very little bloom the following year. This cultivar exhibits strong biennial characteristics. Fuji must be thinned aggressively for best results. Mature trees usually thin adequately with combinations of Sevin and NAA. Follow-up hand thinning is usually necessary to further reduce the number of king fruitlets. Excessive crop may prevent the fruit from maturing to premium quality.

Calculating Parts per Million (ppm)
1 ppm = 1 g active ingredient
per 1,000 L water

Honeycrisp

Although not fully tested for thinning response under Ontario growing conditions, this cultivar is believed to be more sensitive to thinning treatments than Empire. Thin Honeycrisp cautiously, as it can easily become oversized and is very prone to bitterpit. Use of growth regulators, which enhance fruit size, may not be warranted for this large fruited cultivar. Use no more than 2.5 ppm NAA with 1 L Sevin XLR per 1,000 L water as a starting point on established trees.

Gingergold

This relatively new cultivar appears to be in the same sensitivity class to thinners as McIntosh, Northern Spy and Empire. It can be overthinned with high rates of NAA or strong combinations of NAA and Sevin XLR or Accel plus Sevin XLR.

Suggested Rates for Chemical Thinning of Apples

The rates in Table 7–19, *Suggested rates for chemical thinning of mature apple trees,* on page 110, are suggested guidelines only. There is no substitute for personal experience. It is important to keep yearly records on weather conditions, rates, etc., and above all, that some trees be left unsprayed to help assess the thinning response. Use only one of the suggested chemical treatments. For example, with Wealthy, apply NAD or NAA or Sevin, or the combination. Before altering or modifying a treatment that has proven to be effective, refer to a crop consultant.

Defruiting immature apple trees

In some cases, it is desirable to defruit immature apple trees to encourage proper tree development. A dilute spray of NAA at 15 ppm combined with Sevin XLR Plus at 1.5–2 L/1,000 L water 5 days after petal fall, gives acceptable results. Well established, supported trees under minimal stress can carry some crop load in the 2nd year following planting.

Key concepts and benefits of hand thinning

For highly-valued cultivars, hand thinning immature trees is less risky than spray thinning. Hand thin promptly following June drop. Hand thinning:

- helps to increase fruit size and helps and manage fruit development
- helps to single the fruitlets
- balances the number of fruiting spurs with resting spurs
- enhances return bloom
- improves pest control because spray coverage is more uniform on unclustered fruit
- improves efficiency in harvest and handling of crop
- allows the tree to continue developing canopy
- helps to prevent runted trees.

Promalin to Improve Fruit Shape of Delicious

Promalin is a plant growth regulator used on Red Delicious apples. Promalin improves the "typiness" or shape of Red Delicious apples through elongation of the fruit and development of more prominent calyx lobes. Promalin contains a mixture of benzyladenine and 2 types of gibberellins. For satisfactory results when using Promalin, time the application carefully, pay attention to the label and ensure complete spray coverage.

Precautions

- If Promalin is applied at higher rates or volumes than those recommended on the label or where blooms are weak or frost-injured, fruit thinning may occur. Promalin use may also increase the amount of thinning achieved with subsequent blossom thinning sprays.

- Apples may not respond to Promalin if spur vigour is low or the king blossoms have been damaged by frost.

- Do not apply Promalin if rain is expected within 6 hours.

- Do not apply when air temperatures are lower than 24°C or greater than 32°C.

Application notes

- For optimum results, apply Promalin between full king bloom and early petal fall. Applications earlier or later are likely to produce unsatisfactory response.
- High relative humidity and slow drying conditions favour maximum absorption. Preferably, apply in morning or evening.

Ethephon to Promote Fruit Colouring

Ethephon (Ethrel) has the following effects on trees and fruit, depending upon the time and rate of application.

- Ethrel stimulates ripening, colour development and fruit drop. To prevent excessive premature drop following the use of Ethrel, apply a suitable stop-drop product such as naphthaleneacetic acid (NAA). Two applications are required: 1 as a tank-mix at the time Ethrel is applied and the second 5 days later. Apply the stop-drop at the normal rate recommended on the label.
- Spray just the number of trees that can be harvested over a 2 or 3 day period. Depending on cultivar and air temperature, fruit will be ready to harvest 5–10 days after the spray is applied. After spraying, check the maturity of the apples on a daily basis (e.g., pressure, starch, flavour, colour). A few trees sprayed at 3–4 day intervals are easier to manage than a large number sprayed at one time. Make sure a market is available for the treated apples before you spray, especially with early cultivars.
- Rates of application depend on cultivar, date of application, tree vigour, temperature, weather conditions and degree of response required. The response to Ethrel is a chemical reaction and therefore depends on temperature. For this reason early cultivars, such as Jerseymac and Paulared, require less material than later cultivars. On early cultivars use 0.75–1.5 L of Ethrel/ha with sufficient water to wet the trees thoroughly. McIntosh requires 1.5–4.25 L/ha. Use the higher rate early in the season on trees high in nitrogen, or on poorly-pruned trees. Lower rates may be better nearer normal harvest on young, well-pruned trees, or on trees low in nitrogen.
- Best results are obtained when Ethrel is applied 2–3 weeks before harvesting. Be sure and apply Ethrel uniformly, since it works only where the spray touches.

Chemical Control of Preharvest Drop of Apples

Cultivars differ in their tendency toward preharvest drop. In this respect, McIntosh gives the greatest concern in Ontario. Conditions associated with premature fruit drop include:

- trees with high nitrogen content during late summer
- trees carrying a heavy crop
- hot days and warm nights just before and during harvest
- trees deficient in either moisture or the nutrients boron or magnesium
- trees heavily infested with spotted tentiform leafminer.

Products such as FRUITONE-N, and FRUIT FIX CONCENTRATE contain NAA (naphthaleneacetic acid) and are registered to control drop on apples. These contain the same active ingredient, NAA, used earlier in the season for thinning the crop. The concentration of NAA differs for the 2 purposes.

- Apply NAA as soon as the first sound apples begin to drop, at the rate of 10 ppm (single strength rate). Timing is important. Do not confuse the normal preharvest drop of sound apples with those that have been pushed off, or are dropping because of insect, disease, or nutritional deficiency.
- NAA is effective for 7–10 days after spraying. For stop-drop prevention beyond this, repeat the application of a single strength rate every 7 days. It takes 1–2 days for NAA to take effect if applied before any harvest has taken place. If applied after the orchard has been spot picked it may take longer to take effect. Therefore, apply NAA as soon as the spot pick is finished. Do not apply NAA closer than 5 days before harvest. Refer to the label.
- Apply NAA in a dilute spray. A dilute application favours more uniform coverage. This is important because NAA is only locally systemic and high volumes of water take longer to dry and allow increased absorption of NAA. The optimum conditions for maximum absorption are at or near

21°C–24°C and high humidity. Absorption is less on foliage injured by insects, diseases or frost, and at temperatures below 16°C.

- Adding a non-ionic type spreader sticker, e.g. Agral 90, improves absorption of NAA under less than ideal weather conditions.

NAA inhibits fruit abscission but the fruit continues to mature at an accelerated rate. The higher the concentration used and the greater the number of applications, the greater the ripening effect. One application of single strength (10 ppm) has little effect on direct ripening.

- Do not store apples, particularly McIntosh, for long (late opening controlled atmosphere (CA) or long-term cold) if they have been treated with NAA. Market apples immediately if tress were treated a 2nd time with NAA.

Recommendations for Use of ReTain

ReTain is a plant growth regulator and an effective preharvest drop control agent for apples (Honeycrisp, McIntosh, Red Delicious, Northern Spy). It works by inhibiting the production of ethylene in maturing apples.

- Apply this material 4 weeks before anticipated harvest date. ReTain may also delay maturity of apples on the tree, allowing a longer harvest window for a particular variety. Although ripening in ReTain-treated fruit is temporarily delayed, treatment with ReTain may increase soluble solids, colour, fruit size, fruit firmness and reduce the incidence of water core.
- Pick fruit treated with ReTain at the same internal maturity (based on starch-iodine tests) as untreated fruit. There may be a 7–10 day delay from the beginning of predicted harvest date of untreated fruit to the beginning of the harvest of ReTain-treated fruit.

Recommended use 4–5 weeks before anticipated harvest

- Use one, 333 gram pouch (50 g active ingredient) of ReTain/0.40 ha (1 ac.). Use with Sylgard 309 (organosilicone surfactant) at 0.5–1.0 L of Sylgard 309/1,000 L of water.
- Apply 4 weeks before anticipated harvest, adjusted for any seasonal differences that have advanced or delayed the "normal" harvest date for that year. If this date is elusive, it is better to be early (5 weeks) rather than late (3 weeks). Late applications will not perform well because ethylene production within the plant may have already begun and this is difficult to suppress once initiated. To help determine the beginning of the "normal" harvest period, refer to historical trends for harvest dates for each cultivar in your area.

Precautions

- When mixing ReTain with the surfactant, because Sylgard 309 has a tendency to foam, keep agitation to a minimum.
- To minimize foaming, add Sylgard 309 last and when the tank is full. Compatibility and performance data for ReTain with antifoam products are not available.
- Do not use surfactants other than Sylgard 309; they are not registered with ReTain in Canada. If the rate of ReTain is reduced, maintain the Sylgard rate at a 0.05%–0.1% v/v ratio.
- Discard any unused spray material at the end of each day.
- Do not tank-mix with other products except Dipel or Foray. Combination effects and potential interactions between ReTain and NAA (napthaleneacetic acid) or Ethephon products have not been thoroughly evaluated. Use of these products on ReTain-treated blocks may negate or reduce the benefits of ReTain.
- Do not overhead irrigate for 8 hours after applying.
- Adjust spray water volumes based on tree size and spacing. Do not apply to the point of runoff, but wet the tree under slow drying conditions. Use tree row volume (TRV) reductions cautiously — test on a few rows or small blocks to gain a level of comfort with this technique. For many orchards, 1,000 L/ water/ha is adequate for size-controlling rootstocks.
- For best results, have spray water at a pH of between 6 and 8.

For best storage performance of ReTain, segregate treated fruit from untreated fruit to reduce exposure to ethylene.

Additional considerations when using ReTain

- Spray only trees that are healthy and not under severe drought, insect, disease or nutritional stress. Royal Gala, Gala, Jonagold and Honeycrisp strains appear to be more responsive to this product compared to McIntosh. Using ReTain on these sensitive cultivars can significantly impede crop maturity and development. As a result, apply treatments to Gala strain, Golden Delicious types and Honeycrisp with caution.
- For multiple pick cultivars such as Royal Gala, for best results time application 4 weeks from the 2nd harvest pick date.
- The harvest window for treated cultivars (including Gala) is shorter but delayed, resulting in fewer pickings. This can increase harvest efficiency.

Prevention of Heat Stress and Sunburn in Apples

Surround WP Crop Protectant forms a dry, white, mineral-based particle film that acts as a protectant against sunburn and heat stress. Surround keeps leaf and fruit surfaces cooler, but does not affect tree performance.

Negative effects on overall photosynthesis or colouring of fruit have not been observed when Surround is present in the canopy and on fruit as a uniform particle film. Problems can result from applications that lead to caking of Surround on the fruit.

Application instructions: Begin Surround applications soon after the crop load has been reduced by chemical thinning, and before hot weather. Make 2 applications, 7 days apart, using 50 kg of product/1,000 L/water. Spray to the near-drip point. For typical semi-dwarf trees in full foliage, use 1,000–2,000 L/water/ha. Apply additional sprays as necessary to maintain a visible film on plant foliage and fruit. Apply these subsequent sprays using 25–50 kg of Surround/1,000 L of water, every 14–21 days.

During wetting events in the orchard the film changes, making it less visible. The hazy bluish-green look of the film returns when the foliage dries. Under average growing conditions without repeated heavy rainfall, the retention and redistribution of Surround is relatively good.

Precautions: Fruit from trees treated with Surround for the entire growing season may be less mature at harvest than fruit from untreated trees.

Surround residues may be visible on the fruit at harvest, unless only early-season applications are made. Most residues wash off with packing line brushing and forced water sprays. However, if fruit is not waxed after harvest, slight residues may be visible even after washing. To reduce the amount of visible residue on the fruit at harvest, allow a 2 month interval from the last spray to harvest. If your anticipated harvest date for a cultivar like Golden Delicious is mid-October, stop treating with Surround in mid-August. Otherwise, observe a 1-day to harvest interval.

Do not mix Surround with spreaders, stickers or anti-foaming agents. Do not spray when bees are actively foraging. Do not re-enter the orchard for 4 hours after application.

For detailed application instructions and precautions, refer to the product label.

8. Berry Crops

BERRY CROP NUTRITION

Blueberries, Highbush

Blueberries perform best on acidic, well-drained soils with a high organic matter content.

- Before planting, test to determine the pH of the soil and fertilizer requirements.
- Incorporate acidic peat moss with the soil in the planting hole to significantly improve plant establishment and development. Dry peat moss will wick soil moisture away from plant roots, so be sure it is thoroughly moistened before planting. For more information, see *Managing Organic Nutrient Additions* on page 30.

pH requirements

Blueberries require a soil pH between 4.2 and 5.0 for optimum growth and production. A soil pH above 6.5 usually cannot be lowered economically using sulphur or peat moss. For this reason, choose the site for blueberry production carefully.

- If the soil pH is too high but less than 6.5, acidify by incorporating elemental sulphur and/or acidic peat moss prior to planting. (See Table 8–1, *Amount of sulphur required to lower soil pH.*) This also provides essential organic matter.
- Incorporate sulphur 1 year prior to planting to allow sufficient time for the sulphur to acidify the soil.
- Check the soil pH annually in the plant row and add sulphur when necessary.

Fertilizer for blueberries

Nitrogen (N)

Highbush blueberries respond best to ammonium forms of nitrogen. Use ammonium sulphate (21% N) if the soil pH is above 5.0 and urea (46% N) if the pH is below 5.0. Avoid using the nitrate form of nitrogen on highbush blueberries.

- In the spring after planting, apply a total of 12 g of actual nitrogen per bush in a split application. Increase the rate of nitrogen each year until a total of 36–48 g/bush is applied. Apply the nitrogen just prior to bud break, petal fall and early July.
- Distribute the fertilizer in a circle from 30 cm around the plant to just beyond the spread of the branches. On older bushes, apply most of the fertilizer under the outer spread of the branches. (See Table 8–2, *Nitrogen requirements for highbush blueberries.*)

TABLE 8–1. Amount of sulphur required to lower soil pH (kg/ha)

Soil type	For each 1.0 pH unit	For each 0.1 pH unit
sand	350	35
sandy loam	750	75
loam	1,100	110

Example: the initial pH of a sandy loam soil is 6.2; the desired soil pH for blueberries is 4.8.
The soil pH must be lowered by 6.2–4.8 = 1.4 units. Therefore, 1.4 x 750 = 1,050 kg/ha of sulphur is required.

TABLE 8–2. Nitrogen requirements for highbush blueberries

	April 1–15	May 15	July 1
Plant Age	(grams N/plant)		
Newly set	0	6	6
1 year	3	6	6
2 year	6	6–12	6–12
3 year	9	6–12	6–12
4 year	12	12–18	6–12
5 year	15	12–18	6–12
6 year or older	18	12–18	6–12

Phosphorus (P) and Potassium (K)

Apply phosphorus and potassium according to soil tests. Consult Table 8–4, *Phosphorus and potassium requirements for highbush blueberries, strawberries, raspberries, currants, gooseberries* for soil test interpretation. A single application of phosphorus at soil preparation time is usually all that is required. It is critical to correct phosphorus deficiencies prior to planting.

Apply all of the required potassium early in the spring under the outer branches of the bushes as described for nitrogen. Potassium can be mixed and applied with the spring nitrogen. Use sulphate of potash magnesia (22% potash, 11% magnesium) or potassium sulphate (50% potash). Blueberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60).

Other nutrient requirements

Magnesium (Mg) deficiency may occur on blueberries. Soil and/or foliar applications of magnesium are required to correct this deficiency. For soil applications, 80 kg Mg/ha is required where a confirmed deficiency exists. For soil application, use magnesium sulphate (Epsom salts, 9.5% Mg) or sulphate of potash magnesia (21% potash, 11% Mg). Since sulphate of potash magnesia contains potash, adjust the rate of application to coincide with potash requirements. For foliar sprays, 1.9 kg Mg/1,000 L of water (20 kg magnesium sulphate, Epsom salts) with at least 2,000 L/ha should correct the deficiency. Annual foliar sprays may be necessary.

Leaf analysis

Leaf tissue analysis can help to assess the nutrient status of the plants and more accurately determine fertilizer requirements. In late July, take leaf samples from halfway down the new shoot growth of the current season. For adequate representation, collect at least 100 leaves throughout the sampling area. Sample areas with different soil, plant vigour, fertility programs, etc., separately. See Table 8–3, *Standard ranges for nutrient levels in highbush blueberry leaves.*

TABLE 8–3. Standard ranges for nutrient levels in highbush blueberry leaves

Element ( )	Acceptable Range
Nitrogen (N)	1.7–2.3%
Phosphorus (P)	0.15–0.40%
Potassium (K)	0.36–0.7%
Calcium (Ca)	0.3–0.8%
Magnesium (Mg)	0.12–0.3%
Manganese (Mn)	150–500 ppm
Iron (Fe)	30–100 ppm
Zinc (Zn)	10–100 ppm
Boron (B)	15–50 ppm

See Appendix B, page 232, for a list of accredited labs.

TABLE 8–4. Phosphorus and potassium requirements for highbush blueberries, strawberries, raspberries, currants, gooseberries

PHOSPHORUS				POTASSIUM		
		Phosphate required kg P_2O_5/ha				Potash required kg K_2O/ha
Soil test (ppm P)	Rating	New plantings	Established plantings	Soil test (ppm K)	Rating	
0–3	LOW	140	100	0–15	LOW	130
4–5		130	90	16–30		120
6–7		120	80	31–45		110
8–9		110	70	46–60		100
10–12		100	70	61–80		90
13–15		90	60	81–100		80
16–20	MEDIUM	70	50	101–120	MEDIUM	70
21–25		60	40	121–150		60
26–30		50	30	151–180		40
31–40		40	20			
Above 40	HIGH	0	0	Above 180	HIGH	0

Currants and Gooseberries

It is essential to adequately prepare soil before planting currants and gooseberries.

- Prepare the soil at least a year before planting so the plants can maintain productivity and grow successfully in the same location for many years.

Currants and gooseberries grow best in cool, well-drained, deep, loamy soils. The soil should have a rich supply of organic matter, at least 2%–3%, to promote good drainage, aeration and moisture retention.

- Apply 45 t/ha or 4.5 kg/m^2 of well-composted manure in late summer or fall before planting. Other organic materials such as weed-free straw may be used, but these materials should be well decomposed by planting time. For more information on organic matter consult *Managing Organic Nutrient Additions* on page 30.

pH requirements

An acceptable soil pH for currants and gooseberries is between 5.5 and 7.0. A slightly acid soil (pH 6.1–6.6) is best. Liming of soil may be required to raise soil pH to 6.1.

- If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil Acidity and Liming* on page 28. Micronutrients may become limiting when soil pH is above 7.0.

Fertilizer before planting

- Work phosphorus and potassium fertilizer into the soil in early spring a few days before planting.
- Incorporate nitrogen before planting or apply in a band around the bush several weeks after planting. Apply fertilizer at least 30 cm away from the base of the bush to avoid burning roots with the nitrogen.
- If planting takes place in the fall, incorporate required phosphorus before planting, but delay applying nitrogen and potassium until the following spring.

Nitrogen (N)

- Incorporate or band 5 g of actual nitrogen per bush in the planting year.

Phosphorus (P)

- Test the soil before planting and incorporate the required amount of phosphorus according to the soil test results. (Table 8–4, *Phosphorus and potassium requirements for highbush blueberries, strawberries, raspberries, currants, gooseberries*, on page 116) Phosphorus must be incorporated prior to planting to correct phosphorus deficiencies. Phosphorus is not easily leached from the soil. This makes it difficult to correct a problem after the crop is planted. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.

Potassium (K)

- Test the soil before planting and apply the required amount of potassium according to the soil test results. (Table 8–4 on page 116.)
- Currants and gooseberries are sensitive to injury from the chloride contained in muriate of potash (0-0-60). Use sulphate of potash or sulphate of potash magnesia instead.

Fertilizer in established plantings

- Apply fertilizer early each spring according to soil tests. If phosphorus and potassium are not broadcast over the entire area, reduce rates to the percentage of area receiving the fertilizer.
- If the fertilizer is banded, band 30 cm from the base of the plant.

Nitrogen (N)

- Apply 10 g nitrogen per bush in the year after planting. In subsequent years, apply 20 g/bush.

Potassium (K)

- Apply as according to soil test, or assume a moderate level and apply as indicated in Table 8–4 on page 116.

Raspberries

Raspberries have a fine, fibrous root system. They prefer a deep, well-drained soil. Raspberry soils need good water retaining ability and a high organic matter content, approximately 3%. For more information on organic matter, consult *Managing Organic Nutrient Additions* on page 30.

pH requirements

Raspberries grow best at a soil pH of 5.5–6.5, although they can grow well in soils with a higher pH. Liming of soil may be required to raise soil pH to 6.1.

- If lime is needed, apply at least 6–12 months before planting. For more information on lime, consult *Soil Acidity and Liming* on page 28. Micronutrients may become limiting when soil pH is above 7.0.

Fertilizer for raspberries

Nitrogen (N)

Recommended nitrogen rates are noted in Table 8–5, *Recommended nitrogen rates for raspberries.* Avoid applying excessive nitrogen. It can reduce the number of berries per cane and lead to lower yields. Sources of nitrogen and nitrogen equivalents, are noted in Table 3–8, *Fertilizer materials — primary nutrients,* on page 34.

- For summer and fall-bearing raspberries, apply nitrogen in early spring (late March–early April). Late applications may lead to winter injury. For fall bearing raspberries, winter injury is not a concern since canes are removed each spring. However, delayed ripening can be a potential problem where nitrogen is applied in excess.

TABLE 8–5. Recommended nitrogen rates for raspberries

	kg N/ha/season
planting year	30–40
2nd year	40–60
3rd and following years	45–75

Use the lower rates on non-irrigated crops and heavier soils. Apply higher rates to irrigated crops and sandier soils.
See Appendix B, page 232, for a list of accredited soil testing laboratories.

Phosphorus (P) and Potassium (K)

- Use a soil test to determine the need for phosphorus and potassium before planting. Apply the required amount of phosphorus and potassium according to the soil test.
- Incorporate phosphorus prior to planting to correct phosphorus deficiencies. Phosphorus does not move readily through the soil from the surface application.
- Do not apply more phosphorous than is required. Excessive levels of phosphorus can induce deficiencies of essential nutrients such as zinc.
- If the soil test recommends high rates of potash, use sulphate of potash (0-0-50) or sulphate of potash magnesia (0-0-22). Raspberries are sensitive to high chlorides. Some root injury has been observed on sandy soils where muriate of potash (potassium chloride, 0-0-60) has been used at a high rate. For sources of phosphorus and potash, refer to Table 3–8 on page 34.
- Once plants are established, take soil samples from where plants are rooted, rather than from between the rows. Complete soil sampling every 2–3 years.

Leaf analysis

- Collect fully expanded mature raspberry leaves taken from fruiting canes in late July. (See Table 8–6, *Ranges for nutrient levels in raspberry leaves.*) These ranges provide a guide for interpreting results. Variation can occur because of cultivars, soil type and cultural practices.

TABLE 8–6. Ranges for nutrient levels in raspberry leaves

Element	Range
nitrogen (N)	2.0–3.5%
phosphorus (P)	0.2–0.5%
potassium (K)	1.0–2.0%
calcium (Ca)	0.8–2.5%
magnesium (Mg)	0.25–0.5%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
copper (Cu)	5–20 ppm
boron (B)	20–60 ppm

See Appendix B, page 232, for a list of accredited laboratories.

Strawberries

Strawberries are shallow-rooted, perennial plants. Heavy demands are placed on the root system, especially in the short period when berries are developing. Strawberries require well-drained soils with 2% or higher organic matter and high fertility. Providing an optimum environment for strawberry root growth is important to obtaining a profitable, perennial planting.

One Year Before Planting Strawberries and Raspberries

Adjust soil pH and organic matter at least 1 year before planting. Plant a weed-smothering cover crop and incorporate it back into the soil to build up organic matter. Liberally apply well-composted manure (45 tonnes of cattle manure/ha) and incorporate into the soil the year before planting. For information on manure or other sources of organic matter, consult *Managing Organic Nutrient Additions* on page 30.

Test the field soil for phosphorus, potassium, magnesium and pH. Information on soil testing and a list of soil testing laboratories that have been accredited by OMAF can be found in *Benefits of the OMAF-accredited soil testing program* on page 25 and Appendix B, *Accredited Soil Testing Laboratories in Ontario*, on page 232.

pH requirements

The optimum soil pH for strawberry production is 6.0–6.5. Strawberries will grow at a wider range of soil pH, however some micronutrients become less available as pH increases. This may be a problem when soil pH is above 7.0. A soil pH below 5.6 on clay loam and below 6.1 on sandy loam should be adjusted upwards by applying lime the year before planting. For more information on pH, consult *Soil Acidity and Liming* on page 28.

Careful and detailed planning is important prior to planting.

Fertilizer for new plantings (the planting year)

Phosphorus (P)

- Use soil test results to determine the best rate of phosphorus to apply. Table 8–4, *Phosphorus and potassium requirements for highbush blueberries, strawberries, raspberries, currants, gooseberries*, on page 116 shows soil test values and fertilizer requirements for new strawberry plantings.
- Work phosphorus into the soil before planting. Soils differ in the amount of phosphorus available to plants. Generally, fields cultivated for a long time require less phosphorus than recently developed fields.

Starter Solutions:

- If the transplanter allows, consider using a starter solution at planting. This helps the plant establish, particularly if the soil is cold, since the amount of phosphorus available is significantly reduced when soil temperatures are low.
- Use a starter solution high in phosphorus such as 10-52-10, 6-24-6 or 10-24-0. Follow the manufacturer's suggested application rate.

Potassium (K)

- Use soil test results to determine the best rate of potassium to apply. Incorporate potassium into soil before planting. Side dressing of potassium is not generally recommended.

Nitrogen (N)

- Nitrogen can be applied with the P and K, or as a side dressing 2–3 weeks after planting. Apply 50 kg of N/ha. See Table 3–8, *Fertilizer materials — primary nutrients*, on page 34 for nitrogen content of fertilizers.
- Apply an additional 25–35 kg N/ha in mid-August to further invigorate plants as they initiate fruit buds for the following year's crop.
- Use whatever form of nitrogen is economical. Brush pelleted forms, such as ammonium nitrate, off the leaves to prevent burning. Do not apply when leaves are wet.
- Urea forms of nitrogen may volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporating the urea prevents this problem.

Strawberries require annual applications of nitrogen. The timing of nitrogen application is as important as the rate of nitrogen. Improper timing and/or rates of nitrogen may lead to an increase in winter injury, softer fruit, and higher incidence of disease.

- Adjust nitrogen rates proportionately if manure was applied. (See Table 3–5, *Average amounts of available nutrients for different types of manure*, on page 31).
- For more information about food safety and the environmental effect of applying manure, please see *Environmental concerns with manure* on page 32 and *Food safety concerns with manure application and timing* on page 33.

Fertilizer for established plantings

Nitrogen (N)

Do not apply nitrogen in the spring, particularly on vigorous varieties. Spring applications cause extra vegetative growth and vigour, resulting in softer fruit and dense foliage canopies. This increases the potential for botrytis fruit rot. Although spring-applied nitrogen may increase berry size, it also delays maturity by a day or two.

Benefits have been reported from applying low rates of nitrogen (10–20 kg N/ha) to coarse-textured soils in the spring after mulch removal. Established fields on sandy soils or fields suspected of having winter injury might benefit from light spring applications of nitrogen. Experiment with spring-applied nitrogen on a small scale.

- The best time to apply nitrogen in established fields is at renovation. After mowing the foliage, apply 50 kg N/ha using whatever form of nitrogen is economical. (See Table 8–7, *Recommended nitrogen (N) rates for strawberries.*)
- Brush pelleted forms such as ammonium nitrate off the leaves to prevent burning. Do not apply nitrogen when leaves are wet. Urea forms of nitrogen can volatilize under certain conditions. Volatilized ammonia can cause strawberry leaves to blacken. Incorporating urea prevents this problem.
- Apply an additional 25–35 kg N/ha in mid-August to assist the plant in forming next year's fruit buds.
- Ensure soils are well irrigated after renovation, throughout the summer and early fall. Adequate soil moisture is needed to optimize nitrogen uptake.

Phosphorus (P)

- If a soil test shows phosphorus is needed, apply at renovation with nitrogen and potassium.
- Excessive phosphorus levels may cause zinc deficiency, especially on sandy soils.

Potassium (K)

- Apply potassium, as determined by a soil test, at renovation with nitrogen and phosphorus. This allows incorporation. Use soil testing and leaf analysis to determine what rate to apply.
- Excessive levels of potassium induce magnesium deficiency, particularly on sandy soils.

TABLE 8–7. Recommended nitrogen (N) rates for strawberries

	Before planting or 2–3 weeks after planting	**Renovation (after harvest)**	**Mid-Aug.**
Planting years	50 kg N/ha		25–30 kg N/ha
Established plantings		50 kg N/ha	25–30 kg N/ha

Leaf analysis

Leaf analysis can help assess the nutrient status of strawberry plants and more accurately determine fertilizer requirements.

- Take leaf samples by July 1 for fruiting or August 20 for non-fruiting plantings. Collect at least 50 fully expanded, recently matured leaves, with petioles removed. Sample different varieties and plantings separately.
- See Table 8–8, *Optimum nutrient level range of strawberry leaves* for interpretation of leaf analysis values. For more information refer to OMAF Factsheet, *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

TABLE 8–8. Optimum nutrient level range of strawberry leaves*

Nutrient	**Optimum Range**
nitrogen (N)	2.0–3.0%
phosphorus (P)	0.20%–0.50%
potassium (K)	1.5%–2.5%
calcium (Ca)	0.5%–1.5%
magnesium (Mg)	0.25%–0.50%
manganese (Mn)	20–200 ppm
iron (Fe)	25–200 ppm
zinc (Zn)	15–100 ppm
boron (B)	20–60 ppm

* Fully expanded, recently matured strawberry leaves with petioles removed, collected before July 1 in fruiting fields and before Aug. 20 in non-fruiting fields.

See Appendix B, page 232, for accredited laboratories.

Micronutrients for Berry Crops

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Apply only the deficient nutrient in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency occurs mainly on alkaline soils (pH greater than 7.0), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, on sandy knolls, or exposed and eroded subsoils. Boron deficiency can have an effect on growth and fruiting.

- Currently there is no accredited soil test for boron in Ontario.
- Use a leaf analysis to check for and confirm boron deficiencies.
- If a deficiency is confirmed, use soil or foliar applications of boron to improve boron in plant tissues. There are several sources of boron. Check the manufacturer's recommended rates and timing of applications.

Iron (Fe)

Iron is abundant in most soils. However, its solubility is very low. Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near previous lime or building plaster storage sites where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only 1 side or 1 branch of the plant is affected.

- Currently there is no accredited soil test for iron in Ontario.
- Confirm a suspected deficiency with a leaf analysis.
- Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Apply iron chelates[1] to correct iron deficiency. These materials can be applied safely as foliar sprays. Consult manufacturer's label for rates and timing information.

Blueberries

Iron deficiency is common on blueberries if the soil pH is too high. Lowering the soil pH corrects this problem in most cases. This is the preferred control method. Foliar applications of iron chelates temporarily correct the deficiency, but annual sprays may be necessary. Consult the manufacturer's labels for details on rates and timing.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip.

- Confirm a suspected deficiency with leaf analysis and use soil tests to determine the status of manganese. An OMAF soil manganese index value greater than 8 provides adequate manganese to the crop.
- If manganese is required, apply as a foliar spray of manganese sulphate or chelate. Use a spreader sticker with manganese sulphate. Soil applications of manganese are not effective. Consult manufacturer's label for complete information on rates and timing.

Zinc (Zn)

Zinc deficiencies rarely occur on soils where manure was applied. Zinc deficiency symptoms include short internodes, small narrow leaves and interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes".

- Confirm a suspected deficiency with leaf analysis and use soils tests to determine the status of zinc. An OMAF soil zinc index value greater than 8 provides adequate zinc to the crop.
- Where a zinc deficiency has been confirmed, check manufacturer's recommended rates and timing for application of zinc products.

Warning: Do not concentrate nutrient sprays.

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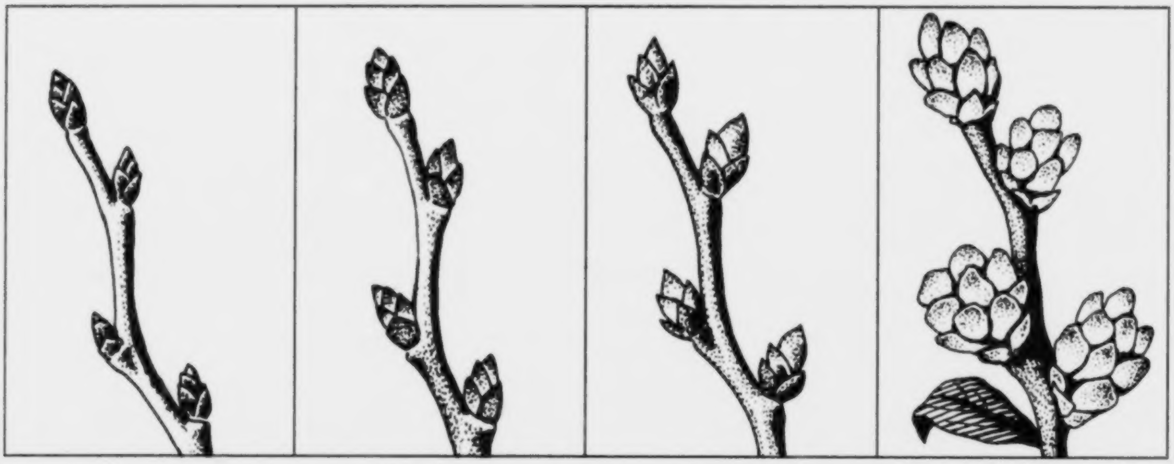
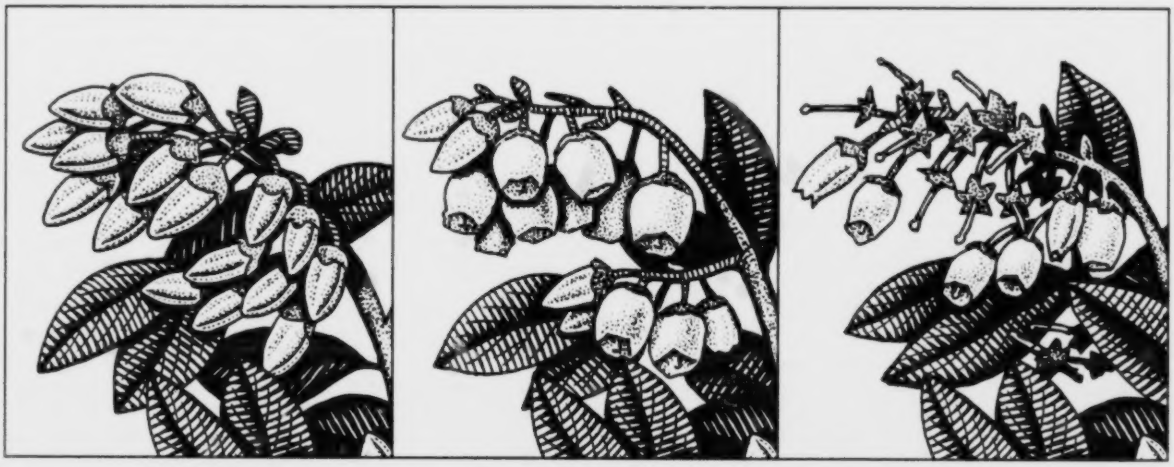
[1] Use chelates recommended for foliar sprays.

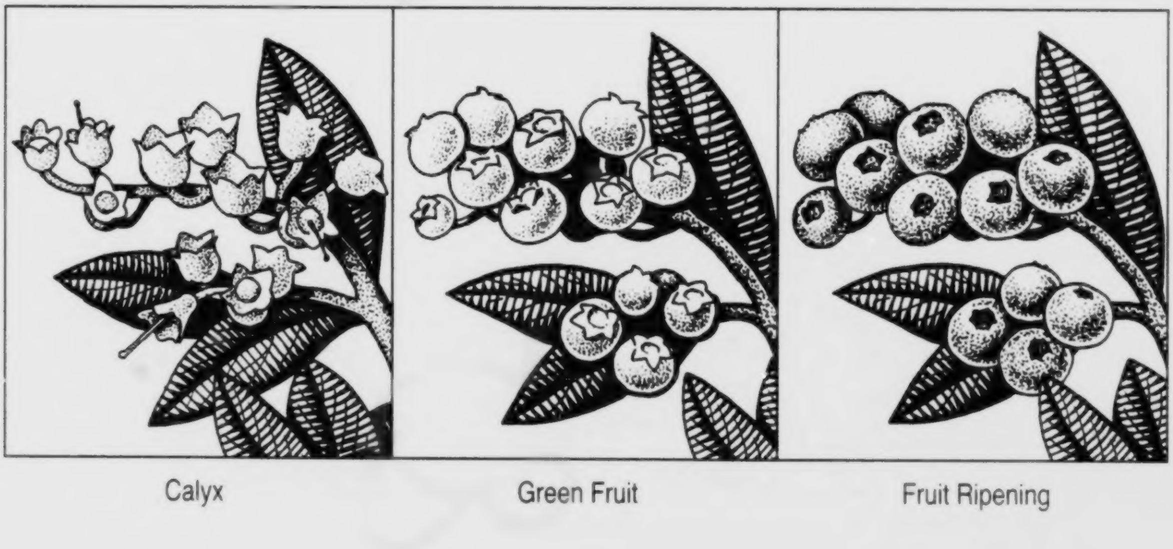
FIGURE 8–1. Blueberry growth stages



Dormant Bud Swell Green Tip Bud Cluster



Pink Bud Bloom Petal Fall



Calyx Green Fruit Fruit Ripening

BLUEBERRY CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. For mature highbush blueberries, use 700–1,000 L of water per hectare unless otherwise noted on the label. See Table 8–9, *Days to harvest intervals for products used on blueberries*, on page 124.

Diseases and Insects	Materials	Amount/ha	Comments
Bud break & repeat 10–14 days later			
Monilinia Mummy berry	• Funginex 190EC • [5]Topas 250E	1.70 L 500 mL	Apply if mummy berry has been a problem in previous years.
Bud swell			
Leaf tiers	• Decis 5 EC	150 mL	Leaf tier larvae cause damage very early in the season. Apply if leaf tier was a problem in the past. Apply at the bud cluster stage as flower buds begin to swell and pink tissue becomes visible.
Green tip			
Phomopsis stem canker Anthracnose fruit rot	• [9]Cabrio EG • [4]Bravo 500	1.0 kg 7.20 L	Make no more than 2 consecutive applications of Cabrio EG, then alternate with fungicides from different chemical families. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47. Bravo will also control Alternaria fruit rot.
Pink bud			
Phomopsis stem canker Anthracnose fruit rot	• [9]Cabrio EG • [4]Bravo 500	1.0 kg 7.20 L	Make no more than 2 consecutive applications of Cabrio EG, then alternate with fungicides from different chemical families. See Table 4–2 on page 47. Bravo will also control Alternaria fruit rot
First bloom			
DO NOT APPLY INSECTICIDES WHILE BLUEBERRIES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.			
Botrytis twig and blossom blight Botrytis fruit rot (grey mould)	• [5]Supra Captan 80 WDG or [5]Maestro 80 DF • [1]Elevate 50 WDG • [1]Lance WDG • Ferbam 76 WDG	2.25 kg 2.25 kg 1.70 kg 560 g 3.75 kg	Fungicides for botrytis are more important when wet weather occurs. Repeat at 7–10 day intervals through bloom if weather is wet. Ferbam helps control mummy berry. Do not use Ferbam later than mid-bloom. Choose fungicides from different chemical families to reduce the development of resistant strains. SeeTable 4–2 on page 47.
Petal fall			
Cherry fruitworm Cranberry fruitworm	• [9]Guthion Solupak or [9]Sniper • Malathion 25 W • Sevin XLR PLUS	1.12 kg 1.12 kg 2.25 kg 4.00 L	Repeat 10–14 days later. Guthion or Sniper also control plum curculio. Malathion also controls aphids. Do not use Guthion or Sniper in backpack or home garden-type sprayers.
Phomopsis stem canker Anthracnose fruit rot	• [9]Cabrio EG • [4]Bravo 500	1.00 kg 7.20 L	Make no more than 2 consecutive applications of Cabrio EG, then alternate with fungicides from different chemical families. SeeTable 4–2 on page 47. Bravo will also control Alternaria fruit rot. Bravo may cause fruit injury if applied to green fruit.
Fruit ripening			
Fruit rot (*Botrytis* grey mould)	• [5]Supra Captan 80 WDG or [5]Maestro 80 DF • [1]Elevate 50 WDG • [1]Lance WDG	2.25 kg 2.25 kg 1.70 kg 560 g	Spray at 7–10 day intervals if the blossom blight phase of botrytis was not controlled. Choose fungicides from different chemical families to reduce the development of resistant strains. See Table 4–2 on page 47.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Blueberry maggot	• Cygon 480 (highbush) (lowbush) • Lagon 480 E (highbush) (lowbush) • [9]Sniper or [9]Guthion Solupak • Imidan 50WP • Sevin XLR PLUS • Malathion 25 W	830 mL 580 mL 825 mL 600 mL 2.25 kg 2.25 kg 2.25 kg 4.00 L 2.25 kg	Most plantings will not require sprays, however monitor for blueberry maggot using yellow sticky traps. Ontario is considered free from blueberry maggot, except for regulated areas. Growers in regulated areas (including Wainfleet and Charlotteville townships) should spray for this pest. Apply the 1st spray when 1st blueberry maggot are trapped or when berries begin to turn blue, about July 5–15, depending on the area and season. Apply a 2nd spray about 5–12 days later, depending on the product. Protection is needed as long as adults are active. Sniper, Imidan and Cygon provide 10–12 days protection under normal conditions. Residual activity of Sevin and Malathion is much shorter. **Cygon**: maximum 2 applications/season. **Imidan**: maximum 2 applications/season. Do not use Guthion or Sniper in backpack or home garden-type sprayers. See *Blueberry maggot* on page 126.

TABLE 8–9. Days to harvest intervals for products used on blueberries

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the minimum number of days between the last spray and first harvest.

Product name	Preharvest interval
Bravo 500	54
Cabrio EG (highbush)	29
Supra Captan 80 WDG	2
Cygon 480	15
Decis 5EC	14
Elevate 50 WDG	1
Ferbam 76 WDG	40
Funginex 190 EC	60
Guthion Solupak	14
Imidan 50WP	15
Lagon 480 E	15
Lance WDG	0
Maestro 80 DF	2
Malathion 25W	1
Sevin XLR Plus	2
Sniper	14
Topas 250E	60

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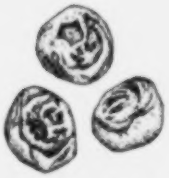
[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

NOTES ON BLUEBERRY DISEASES

Anthracnose fruit rot

Identification



Anthracnose fruit rot is a common fruit rot in Ontario blueberry plants. This disease is also known as ripe rot because it appears during or after harvest. Anthracnose causes the blossom end of ripe fruit to soften. Frequently, orange spore masses seep out of the infected area.

Period of activity

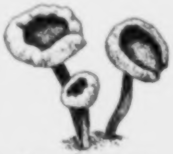
The disease overwinters in infected twigs. Spores spread by splashing rain to bloom and green fruit. Infected green fruit do not show symptoms until they ripen. The disease increases with prolonged periods of warm wet weather during bloom and just before harvest.

Management notes

Overhead irrigation can increase spore dispersal and infection. Bravo applied before bloom and at petal fall reduces overwintering inoculum and twig blights. After petal fall, fungicides for fruit rot suppress, but do not control, this disease. Manage the disease by pruning to encourage air movement within the bush and to reduce overwintering inoculum. Fungicides can assist with control (see page 123).

Mummy berry

Identification



Trumpet-Shaped Spore Structures

Mummy berry causes 2 types of symptoms on blueberry shoots and fruit — infected shoots turn brown and wilt; infected fruit turn pinkish-white and hard, and fall to the ground.

Period of activity

The disease overwinters on the ground in fungal structures, or mummies, which are hard, dark pumpkin-shaped structures about the size of a blueberry. In spring the mummies develop trumpet-shaped cups that produce spores. The spores are released into the air around bud break. Primary infection occurs when new shoots and leaves are infected by these spores and suddenly develop a blighted appearance. These infected tissues produce a second type of spore, which is spread to healthy flowers. A secondary infection forms at the base of the flower where the berry will develop. Infected berries develop normally at first, but begin to turn pinkish or whitish-grey, harden and fall to the ground at harvest time.

Management notes

Certain varieties (i.e. Blueray) seem more susceptible to mummy berry than other varieties. The disease is worse in low-lying areas or beside windbreaks where there is little air movement. Control is achieved by destroying or burying the mummies in the ground before they produce the trumpet-shaped fruiting structures. Fungicides are used to protect buds from primary infection.

Stem cankers

Identification

Several stem cankers and diseases affect highbush blueberries. Fusicoccum forms distinct elliptical cankers on the lower half of the stem. Phomopsis cankers are less defined than fusicoccum, and appear as flattened and elongated areas on the stem. Both cankers can result in rapid wilting and dying of the 2–3 year old blueberry canes. Leaves turn reddish brown and remain attached to the cane.

Period of activity

Infection by canker-causing fungi can occur anytime during the growing season, and especially in wet weather. Die-back symptoms are most obvious in midsummer when bushes are stressed by cropping or drought.

Management notes

Blueberry plants are more susceptible to phomopsis if they are:

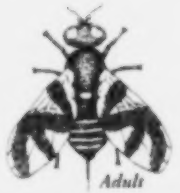
- over-fertilized with nitrogen
- growing in poorly drained soils
- suffering winter injury
- damaged or wounded, i.e. by machine harvesters.

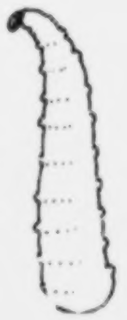
Prune out and burn diseased canes as soon as they appear.

NOTES ON BLUEBERRY INSECTS

Blueberry maggot

The federal *Plant Protection Act* and *Regulations* place movement restrictions on blueberry fruit, plants, soil and containers from areas known to be infested with blueberry maggot. These laws exist to prevent the spread of this pest from infested areas — Nova Scotia, New Brunswick, Prince Edward Island, Maine, New York, Michigan — to non-infested areas such as Ontario, Quebec, B.C. (For more information see Blueberry Maggot in Ontario on the OMAF web site at *www.omaf.gov.on.ca.*)





Identification

The adult blueberry maggot fly is slightly smaller than a housefly. It has a grey-black body with white markings and distinct dark banding on its wings. The immature stage is a white larva that infests blueberry fruit. Blueberry maggot larvae is easily distinguished from other larvae that infest blueberry fruit. (See Table 8–10, *Distinguishing insect larvae found in blueberry fruit.*)

TABLE 8–10. Distinguishing insect larvae found in blueberry fruit

Insect pest	Head	Legs
Plum curculio	Brown head capsule	No legs
Cranberry fruitworm	Brown head capsule	Has 3 pairs legs plus prolegs
Blueberry maggot	No head capsule	No legs

Period of activity

In early July, as the first berries are turning blue, adult flies begin to emerge from pupae in the soil. Emergence and adult activity continues into August. Adult flies lay eggs on developing blueberry fruit and larvae develop inside the fruit. Infested fruit may ripen and soften prematurely. Mature larvae emerge from dropped fruit, then pupate and overwinter in the soil beneath the bushes.

Monitoring and thresholds

- Monitor for blueberry maggot flies using yellow sticky traps, baited with ammonium acetate. These traps are also used for apple maggot. Place traps by mid-June on the perimeter of commercial fields. If abandoned or wild blueberries are nearby, place traps just outside of commercial fields. See Appendix F, *Suppliers of Pest Monitoring Equipment and Biological Control Agents,* on page 238.

Management notes

Insecticides and timings for blueberry maggot control are listed on page 124.

- Norfolk county, Niagara region and Elgin county are restricted areas with quarantines are in place to eradicate blueberry maggot and to prevent its spread.
- In restricted areas, begin sprays for blueberry maggot when berries begin to turn blue or when the first maggot flies are detected on traps.
- In other areas, spray the border of the planting (outer 6–8 rows of blueberries) to reduce the risk of infestation.
- Monitor new plantings closely for blueberry maggot, especially if planting stock originated in an infested area.
- Do not use Cygon or Lagon on blueberries destined for U.S. markets because there is zero tolerance for the active ingredient dimethoate on blueberry fruit in the U.S.
- Insecticides are very toxic to bees. Minimize bee exposure by applying insecticides early in the morning or later in the evening when bees are not actively foraging. Do not spray blueberry plants in bloom.
- If blueberries are bought for re-sale on your farm, do not throw away the culls and unmarketable berries. Deep burial, below the plough layer, is the best way to dispose of this material.

Cranberry and cherry fruitworm

Identification

Larvae of these moths feed on developing fruit. *Cranberry fruitworm* larvae are greenish and about 9.5 mm ($^{3}/_{8}$ in.) long. They tunnel into the fruit, feeding on several berries and filling their tunnels with frass. The cranberry fruitworm ties fruit clusters together with webbing and usually leaves very messy feeding sites. Cranberry fruitworm is the major pest in most areas.

Cherry fruitworm larvae are white or pink with brown or black heads. They also feed on developing blueberries, but stay hidden inside the fruit and do not tie clusters of berries together.

Period of activity

Both pests have a similar life cycle. Adults are active in spring, during bloom. Eggs are laid on developing small green fruit. There is one generation per year.

Monitoring and thresholds

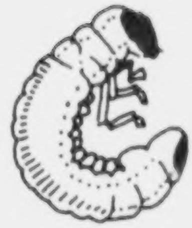
- Use pheromone traps to monitor for cranberry fruitworm. The pheromone for cranberry fruitworm is species-specific and will not attract cherry fruitworm. Pheromone for cranberry fruitworm can be purchased from several suppliers. See Appendix F, *Suppliers of pest monitoring equipment and biological control agents*, on page 238.
- Use pheromone with Pherecon IC traps. Set traps out around mid-bloom. Use 3 traps for 4 ha (10 acres). Hang traps from the outside branches but not above the bush. Check traps twice weekly and record the number of moths trapped on a chart.

Management notes

Insecticides for cranberry fruitworm can be delayed until 5–10 days after peak catch. A 2nd insecticide is required only if trap catches remain high for an extended time.

White grubs

Identification



White grubs are C-shaped, with a tan or brown head capsule and 6 prominent spiny legs. White grubs are the larval stage of beetles, including June beetle, European chafer and Japanese beetle. These larvae can be a pest in blueberry plantings, especially in light soil types. Symptoms of white grub feeding include stunted growth and a decline in plant vigour. Bushes are poorly rooted and can be easily pulled from the soil. Infested roots are often associated with mealy bugs and ants.

Period of activity

June beetle adults are active in late May and early June, European chafer adults in June, Japanese beetle adults in June and July.

Eggs are laid in grassy places. The eggs hatch into larvae, or white grubs, and feed on plant roots. Feeding by European chafer larvae and Japanese beetle takes place in late summer, and again in the spring, until adults emerge. June beetle larvae remain in the soil for 3 seasons, feeding on plant roots throughout each growing season.

Management notes

There are no insecticides registered for white grub control on blueberries. A minor-use registration is in process.

- Do not establish new plantings for 2 years after sod or pasture crops. Keep grassy weeds away from the bushes to make the habitat less favourable for white grubs. Clean cultivation between rows may reduce the populations over time.
- Grass parking lots can serve as a large reservoir for the build-up of grubs. Treat these grass areas like turf or lawns but **do not treat inside the planting**. If 5 grubs/ft.^{2} are found, treat with an insecticide labelled for turf.
- For more information on white grubs see OMAF Factsheet *Grubs in Lawns*, Order No. 97-023.

Bird Control

Birds are often the biggest pest problems in a blueberry planting. For information on bird control see *Wildlife Control, Birds* on page 51.

CURRANT & GOOSEBERRY CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. Check preharvest intervals in Table 8–11.

Diseases and Insects	Materials	Amount	Comments
Just before blossoms open			
	DO NOT APPLY INSECTICIDES WHILE CURRANTS OR GOOSEBERRIES ARE IN BLOOM SEE BEE POISONING ON PAGE 64.		
Leaf spot	• Ferbam 76 WDG	6.75 kg/ha	Use Ferbam on currants only, not gooseberries.
Powdery mildew	• Microscopic Sulphur	5.0 kg/ha	Do not use on "sulphur-shy" American varieties.
Sawfly	• Diazinon 50 W or Diazinon 500 E	1.0 kg/1,000 L 1.0 L/1,000 L	Do not apply Diazinon after the first bloom opens.
Blister aphid	• Malathion 25 W	2.5 kg/1,000 L	
Botrytis grey mould	• [1]Elevate 50 WDG • [1]Lance WDG	1.7 kg/ha 560 g/ha	*Botrytis* infection during bloom can cause early fruit drop, or "run-off" in currants. Apply fungicides at 7–10 day intervals during bloom. Choose fungicides from different chemical families to reduce the development of resistant strains of *Botrytis*. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
Bloom			
Botrytis grey mould	• [1]Elevate 50 WDG • [1]Lance WDG	1.7 kg/ha 560 g/ha	
Postbloom: as soon as bloom is complete			
Leaf spot	Same as for leaf spot above.		
Powdery mildew	Same as for mildew above.		Repeat weekly if warm and humid conditions persist.
Currant fruit fly	• Malathion 25 W	2.5 kg/1,000 L	Spray where this pest was a problem and make a second application 10 days later. For best results apply when the temperature is above 20°C.
10 days after postbloom spray			
Leaf spot	Same as for leaf spot above.		
Currant fruit fly	• Malathion 25 W	2.5 kg/1,000 L	For best results, apply when temperature is above 20°C.
Postharvest			
Leaf spot	Same as leaf spot above.		
Aphids Leafhoppers	• Malathion 25 W	2.5 kg/1,000 L	Spray red and white currants immediately after fruit is picked.

TABLE 8–11. Days to harvest intervals for products used on currants and gooseberries

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the minimum number of days between last spray and first harvest.

Product name	Preharvest interval
Diazinon 500 E	Do not use after first bloom
Diazinon 50W	Do not use after first bloom
Elevate 50 WDG	1
Ferbam 75 WDG	14
Lance WDG	0
Malathion 25W	3
Microscopic Sulphur	1

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

NOTES ON CURRANT AND GOOSEBERRY DISEASES

Powdery mildew

Identification

The fungus causes white felt-like patches on the upper and lower leaf surface, shoots and fruits. Infected plants are often stunted and defoliated. Powdery mildew is a limiting factor in black currant production where susceptible varieties are grown.

Management notes

There are few fungicides registered for control of mildew on currants at this time. Choose resistant varieties. (See Table 8–12, *Disease ratings on selected currant and gooseberry varieties.*)

White pine blister rust

Identification

Symptoms of this disease include yellowish spots on the upper leaf surface and orangish blisters on the lower leaf surface. Infected plants defoliate prematurely, but effects of defoliation are not as severe as for powdery mildew.

Period of activity

The rust fungus spends part of its life on wild and cultivated species of gooseberry and currant, and part on white pine (5-needled pine). In spring, small slightly raised yellow-orange spots appear on the underside of infected currant leaves. These produce masses of yellow-orange spores that can re-infect currant leaves throughout most of the growing season. Later in the season, brownish hair-like structures develop on infected currant leaves. These produce a small spore that travels not much further than 1.6 km (1 mi.) and only infects white pine. The fungus overwinters on white pine and in spring produces spores that can travel hundreds of miles and only infect currants and gooseberries.

Management notes

White pine blister rust is more serious on white pines than it is on currants. Although the rust disease can defoliate currants, it does not appear to significantly affect yield. However, this disease can kill white pine trees. Because white pine blister rust has caused severe economic losses in the forestry industry, currant production is restricted in many parts of the U.S. In Ontario, there is no legislation regulating currant production.

- Do not grow black currants, even moderately resistant varieties, within a 1.6 km (1 mi.) of white pines.
- Destroy wild gooseberry and currant plants within a 1.6 km (1 mi) radius between cultivated currants or gooseberries and nearby white pines. This may help reduce the impact of the disease in a particular area.

TABLE 8–12. Disease ratings on selected currant and gooseberry varieties*

Type	Variety	Mildew Resistance	Rust Resistance[1]
black currant	Ben Alder	resistant	very susceptible
black currant	Ben Connan	resistant	moderately resistant
black currant	Ben Sarek	resistant	moderately resistant
black currant	Titania	resistant	resistant
red currant	Red Lake	susceptible	moderately resistant
red currant	Red Start	susceptible	moderately resistant
red currant	Rovada	resistant	moderately resistant
red currant	Jonkheer van Tets	resistant	resistant
gooseberry	Invicta	resistant	moderately resistant
gooseberry	Hinnonmaki Red	resistant	moderately resistant

* Not all varieties proven acceptable for Ontario conditions.

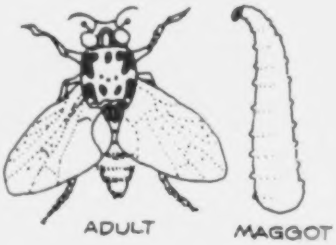
[1] **Resistant**: Does not show symptoms of rust
Moderately resistant: Shows symptoms at low frequency, yield not affected.
Susceptible: Noticeable levels of rust infection, not affecting yield.
Very susceptible: Severe infection, affecting yield.

Source: Adam Dale, University of Guelph, Ontario and Dick McGinnis, McGinnis Berry Crops, B.C., 1999

NOTES ON CURRANT AND GOOSEBERRY INSECTS

Currant fruit fly

Identification



The larva, or maggot, of the currant fruit fly infests currant and gooseberry fruit. Larvae are white, pointed at one end, with no obvious head or legs. The adult fly, slightly larger than a housefly, is approx. 8 mm long, with a brownish-yellow body and distinct dark bands on its wings.

Period of activity

The adult lays its eggs in young, green fruit. The larvae feed inside the fruit and infested fruit drops prematurely. The larvae exit the fallen berries, then pupate and overwinter in the soil.

Monitoring

Currant fruit fly adults can be successfully trapped with yellow sticky boards, baited with an attractant for apple maggot.

- Place traps in the bush at the same level as the fruit. Check traps twice a week from green fruit through to first harvest for currant fruit fly adults.
- No thresholds have been developed, so use the traps to fine tune the timing of insecticides.

Management notes

Raking up fallen berries will reduce pest pressure. Properly timed insecticide applications will control this pest (page 128).

Imported currant worm (currant sawfly)

Identification

Adult sawflies are nearly the size of a housefly, stout bodied with a dark head and thorax, and red-yellow abdomens. The larvae are green worms, similar in appearance to a caterpillar, and blending in well with currant foliage.

Period of activity

Adults are active in May and June, laying eggs on the underside of currant leaves. The larvae appear in great numbers at the green fruit stage and devour foliage just before fruit ripens. Bushes can be completely defoliated. The larvae pupate in the leaf litter. There are 2 generations each year, although only the first causes significant damage.

Monitoring

- Check for signs of leaf feeding twice weekly as fruit develop. Gooseberries are especially susceptible.

RASPBERRY CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. Check Table 8–13, *Days to harvest intervals for products used on raspberries*, on page 133.

Diseases and Insects	Materials	Amount	Comments
Delayed dormant to green tip			
Anthracnose Spur blight Cane blight	• Lime sulphur	35 L/1,000 L	Spray enough water to drip off the plants. Do not use lime sulphur later than 1/4-inch green. This is the first step in a good disease control program.
Prebloom (until blossoms open)			
Anthracnose Spur blight	• Ferbam 76 WDG	2.25 kg/1,000 L	Apply when new canes are 25–30 cm tall and again just before first bloom.
Powdery mildew	• Senator 70WP	500 g/1,000 L or 1.1 kg/ha	In problem areas, spray when mildew is first observed. Repeat in 7–10 days. To prevent resistance, apply no more than 2 sprays.
Raspberry sawfly	• Diazinon 50 W	1.0 kg/1,000 L	Diazinon also controls aphids and raspberry fruit worm. Apply before first bloom.
Raspberry fruitworm	• Malathion 25 W • Diazinon 50 W	4.5 kg/1,000 L 1.0 kg/1,000 L	Repeat in 7–10 days where there is a history of injury. **Apply before first bloom.**
Spring feeding caterpillars Leafrollers	• [9]Guthion Solupak • Foray 48 BA or Dipel 2X DF	1.75 kg /ha 2.8 L /ha 550 g/ha	**Guthion**: Do not use Guthion in knapsack or other home garden-type sprayers. **Apply before first bloom.** **Dipel and Foray**: These insecticides are only recommended for the control of leafrollers. Frequent monitoring of leafroller life stages is recommended. Do not apply these as dilute sprays. For Foray 48 BA, apply in no more than 600 L water/ha.
Clipper weevil	• Malathion 25 W	4.5 kg/1,000 L	Clipped buds and small round holes in petals indicate clipper weevil activity.
Two-spotted spider mite	• Apollo SC • Kelthane 50W	500 mL/ha 2.0 kg/ha	Alternate miticides from year to year. Thorough spray coverage of the lower leaf surface is required. Beneficial mites can be introduced to prevent mite build-up. **Kelthane**: Apply when mite populations are beginning to build and mites are mostly in the nymph stage. Maximum 1 application/season. **Apollo**: Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage. Apply no more than once/season.
Bloom			
	DO NOT APPLY INSECTICIDES WHILE RASPBERRIES AND BLACKBERRIES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.		
Fruit rots on raspberries	• [1]Rovral 50 WP • [5]Supra Captan 80 WDG or [5]Maestro 80 DF • [1]Elevate 50 WDG • [1]Lance 50 WDG	2.0 kg/ha 2.5 kg/ha 2.5 kg/ha 1.7 kg/ha 560 g/ha	Bloom is the most important time to control botrytis grey mould. Begin at 5–10% bloom and, if the weather is wet, repeat every 7 days. Choose fungicides from different chemical families to reduce the development of resistant strains. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47. Captan or Maestro also control spur blight. The rate for Supra Captan 80 WDG and Maestro 80 DF on blackberry is 2.25 kg/ha.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount	Comments
Green fruit			
Leafroller	• Foray 48BA or Dipel 2X DF	2.80 L/ha 550 grams/ha	Leafrollers are not usually a problem in Ontario. Susceptible varieties include Chilliwack, Chilcotin, Tulameen and Comox and other varieties from the Pacific Northwest. Do not apply these as dilute sprays. For Foray 48 BA, apply in no more than 600 L water/ha.
Leafhoppers	• Malathion 25 W	4.5 kg/1,000 L	
Postharvest			
Leafhoppers	• [9]Guthion Solupak or [9]Sniper 50 W • Malathion 25 W	1.12 kg/ha 1.12 kg/ha 4.5 kg/1,000 L	Do not use Guthion or Sniper in knapsack or other home garden type sprayers.
Powdery mildew	• Senator 70 WP	1.1 kg/ha or 500 g/1,000 L	Repeat in 14 days if disease becomes evident on new growth. To prevent resistance, apply no more than 2 sprays.
Two-spotted spider mite	• Agri-Mek 1.9% EC • Kelthane 50W • [3]Pyramite	1.1 L/ha 2.0 kg/ha 600 g /ha	Alternate miticides between years. Thorough spray coverage of the lower leaf surface is required. Beneficial mites can be introduced to prevent mite build-up. Do not use Agri-mek or Pyramite before harvest. **Kelthane**: Apply when mite populations are beginning to build and mites are mostly in the nymph stage. Maximum 1 application/season.
Raspberry crown borer	• Diazinon 500 E or Diazinon 50 W • [9]Guthion Solupak	1.0 L/1,000 L 1.0 kg/1,000 L 2.25 kg/ha	If more than 5% of the crowns are infested, apply this spray to lower portions of canes and to the crown area. Treat infested plantings at least 2 years in a row. **Diazinon**: Apply diazinon in 4,000–5,000 L of water/ha as a drench to crowns and base of plants. Apply in spring to control young larvae before they tunnel into crowns. Apply when new growth is about 10 cm above ground. Do not apply after first bloom. **Guthion**: Apply Guthion in early spring or in mid September to mid October to control eggs and young larvae. Apply in 1,600 L of water/ha.
Phytophthora root rot	• [2]Ridomil Gold 480EC • Aliette WDG	37 mL /100 m of row (Apply in a drench spray to the soil surface in a 1-m band centered over the row. Use at least 2,500 L of water/ha.) 5.50 kg/ha	**Ridomil**: In new plantings, apply as a post-planting soil drench and again in the fall in mid to late October. (no later than Oct. 31). In established plantings, apply Ridomil Gold in the fall only. Do not apply in spring to established plantings. **Aliette**: Aliette WDG is best used as a preventive treatment. Apply no more than 4 sprays/year: 2 in the spring and 2 in the fall. *Spring application:* Apply the first spray of Aliette after bud break at 7 cm of new growth and then again 3–4 weeks later. Do not apply within 60 days of harvest. *Fall application:* Apply when conditions favour disease development (high soil moisture and cool temperatures) and then repeat if necessary 3–4 weeks later. The last fall application should be made at least 30 days before leaf drop. *Precautions:* Crop phytotoxicity is possible when Aliette is mixed with copper. Care should be taken if mixing Aliette with nitrogen-based foliar fertilizer. Incompatibility with some suspension concentrate formulations can occur.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 8–13. Days to harvest intervals for products used on raspberries

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the number of days between the last spray and first harvest.

Product name	Preharvest interval (days)
Agri-Mek 1.9%EC	Use after harvest
Aliette WDG	60
Apollo SC	15
Supra Captan 80 WDG	2
Diazinon 500 E	Use only before bloom
Diazinon 50W	Use only before bloom
Dipel 2X DF	1
Elevate 50 WDG	1
Ferbam 76 WDG	Use only before bloom
Foray 48BA	1
Guthion Solupak	14
Kelthane 50W	7
Lance 50 WDG	0
Lime Sulphur	Do not use after ¼ inch green
Maestro 80 DF	2
Malathion 25W	1
Pyramite	Use after harvest
Ridomil Gold 480 EC	Use after harvest
Rovral	1
Senator 70 WP	1
Sniper	14
Vydate	Use after harvest

NOTES ON RASPBERRY DISEASES

Management Practices to Reduce Diseases on Raspberry

- Plant raspberries on well-drained sites with good air circulation.
- Plant new raspberries on 25–30 cm (10–12 in.) raised beds to improve drainage and reduce the risk of phytophthora root rot. This is especially important on sites with clay loams, fluctuating water tables, or where susceptible varieties will be grown.
- Space rows at least 2.5 m apart. Limit width of plants within rows to 30–45 cm. Thin excess canes in the row.
- Immediately after harvest is finished, prune out fruiting canes and weak growth.
- Keep rows free from weeds.
- In spring, prune out and burn canes or portions of canes showing swelling, scars and cracks.

Cane blight

Identification

Cane blight is a serious raspberry cane disease in Ontario. Diseased canes may die during the winter, or they may leaf out erratically in the spring. Infected canes that initially look healthy may die-back above the point of infection just as harvest begins. Symptoms of cane blight look similar to those caused by cane and crown borers.

Period of activity

The pathogen enters primocanes, or first-year growth, through wounds, and spreads up and down the vascular tissue, causing the cane to become brittle and weak. Symptoms are most evident the following spring. Severely infected canes do not leaf out in the spring, they are unusually brittle and easy to snap or break. Infected canes may leaf out and then die back before harvest.

Monitoring

Cane blight can be diagnosed by scraping back the bark of infected canes to expose the vascular tissue. The diseased vascular tissue beneath the bark is distinctly brown instead of green.

Management notes

- Prevent injury to primocanes. Canes wounded by rubbing against trellis wires, by machine harvesters or by summer pruning are susceptible to cane blight infection. Primocanes can be wounded by rubbing against old canes pruned too high above the ground.
- Carefully prune out old fruiting canes close to ground level after harvest to reduce cane blight.
- Avoid pruning or tipping when plants are wet or just before a rain.

Crown gall and cane gall

Identification

The soil-borne bacteria that cause crown gall infect raspberry roots, crowns and lower stems through wounds. The bacteria induce the plant tissue to grow abnormally, resulting in the production of spongy wart-like galls on infected crowns and roots. The galls eventually become hard and woody as they age. Raspberry plants with numerous galls become stunted and weak. The leaves turn yellow and dry up at the edges. The galls disintegrate over the winter and release the disease-causing bacteria into the soil. New galls often form in the area of the old galls the following spring.

Period of activity

The bacteria that cause crown gall are present in some fields, especially ones where tree fruit or raspberries have grown. Crown gall can also be introduced to new fields on planting stock. Once present the bacteria survive for many years in decaying root galls or alternate hosts. Wounds resulting from winter injury, insect damage or cultivation encourage new crown gall infections.

Management notes

- Do not plant canes infected with crown gall. Purchase disease-free plants from an accredited nursery.
- Do not plant new canes in infested soil.
- Maintain good soil fertility.
- Avoid injury to crown and roots.

Fire blight

Identification

Primocane tips and laterals of infected raspberry canes develop blackened tissue around the veins and frequently wilt or curve down in the form of a shepherd's-crook. Infected fruit or flower clusters appear water-soaked and eventually turn black. Droplets of white or amber bacterial ooze may be excreted from the lesions of infected tissue. Infected berries become hard, dry and brown, and remain attached to the pedicel. The disease is caused by bacteria, similar but not identical to, the bacteria that causes fire blight on apples and pears.

Period of activity

Fire blight infection shows up on susceptible varieties between bloom and harvest. Symptoms on primocanes and laterals may develop soon after high winds, driving rains or hail. These conditions provide small wounds, which allow the bacteria to infect.

Monitoring

Fire blight on raspberry is not common in Ontario. Occasionally it causes severe damage to the variety K81-6 and it has also been observed on Boyne.

Management notes

- To avoid fire blight, do not plant susceptible varieties such as Boyne and K81-6. (See Table 8–14, *Relative resistance of raspberry varieties to cane infection by fire blight.*)
- Avoid overhead irrigation on susceptible varieties. Overhead irrigation can create wounds in plant tissue, favouring infection and spreading bacteria to healthy plants.
- Prune-out infected canes and remove from the planting as soon as observed. Remove infected canes on a dry day to prevent the bacteria from spreading to other canes.
- Insects such as tarnished plant bugs, earwigs and ants can spread the fire blight bacteria and encourage infection. Monitor for these insects and control them if necessary.

TABLE 8–14. Relative resistance of raspberry cultivars to fire blight infection

Cultivar[1]	Lesion length (cm)
Royalty	2.6
Nova	3.2
Polana	3.9
Caroline	4.0
Heritage	5.2
Autumn Britten	4.9
Reveille	5.8
Killarney	6.1
Lauren	5.6
Latham	5.8
Canby	5.7
Algonquin	6.6
Boyne	6.5
Prelude	6.4
K81-6	7.5
Encore	7.5

[1] Cultivars are ranked from most resistant to least resistant.

[2] Plants were inoculated with three isolate of Erwinia amylovora. Lesion length was measured 17 days after inoculation.

Source: G. Braun, A. Jamieson, and P. Hildebrand, Agriculture and Agri-Food Canada, Kentville N.S. 2004. (pers. comm.)

Orange rust of blackberry

Identification

Infected plants produce weak, spindly shoot growth with yellow misshapen leaves in the spring. Leaves on these shoots develop bright orange pustules on the lower surface. This disease only occurs on blackberries, black raspberries and purple raspberries.

Management notes

Unlike most fungus diseases, orange rust is systemic in the plant.

To prevent the disease from spreading, dig out and destroy infected plants early in the spring before pustules break open.

Phytophthora root rot

Identification

Plants infected with phytophthora root rot grow poorly. Primocanes may wilt. Foliage on fruiting canes may die back, especially when drought or the demands of cropping stress the plants. Fewer primocanes emerge each spring.

Period of activity

Phytophthora root rot is caused by a soil-borne fungus. The fungus produces spores that swim in water and infect roots and crowns when soil conditions are very wet. Infections can take place whenever soil temperatures are over 10°C and the soil is wet, but most frequently in spring and fall.

Monitoring

The disease frequently develops on plants grown on heavy, compacted or poorly drained soil. Confirm diagnosis by digging up plants and scraping away the outer tissue of diseased crowns. Phytophthora infections cause a reddish discoloration just beneath the bark of the infected crown. Certain varieties are very susceptible to phytophthora and are much more likely to develop the disease than tolerant varieties.

Management notes

Phytophthora root rot can be partially managed by the use of fungicides, but crop management practices are more important for preventing and controlling this disease.

- Select fields with excellent drainage and avoiding low-lying areas. Consider using raised beds to keep the water table below the plant roots.
- Some varieties of raspberries are very susceptible to phytophthora while others are fairly resistant. (See Table 8–15, *Field resistance of red raspberry varieties to phytophthora root rot.*)
- Avoid growing susceptible varieties, especially in heavier soil types or on soils prone to flooding.

TABLE 8–15. Field resistance of red raspberry varieties to phytophthora root rot

Partially Resistant	Susceptible	Very susceptible
Latham[1]	Heritage[1]	Titan[1]
Killarney[1]	Taylor[1]	Canby[1]
Boyne[1]	Newburgh[1]	Ruby[1]
Prelude[2]	Royalty[1]	Lauren[2]
Anne[2]	Josephine[2]	Encore[2]
Nova[2]		Polana[2]
Caroline[2]		NY253[2]
NY258[2]		

Source: [1]W. Wilcox and M. Pritts, and [2]Courtney Weber and Jeremy Pattison 2003, Cornell University

Verticillium wilt (bluestem)

Identification

Verticillium wilt can be caused by 2 related soil-borne fungi. The fungi infect plants through roots, eventually colonizing and plugging the vascular system. Leaves develop a dull green colour, dry up and drop, beginning at the bottom of the plant. Frequently, only canes on one side of infected plants wilt or show symptoms. A blue or purple streak on the stem is characteristic of this disease. Black raspberries are much more susceptible to verticillium than red raspberries.

Period of activity

The disease infects in cool weather, especially in poorly drained soils or after wet springs. The symptoms develop in warmer weather and are associated with periods of water stress or crop development.

Management notes

- To control verticillium, do not plant raspberries following tomatoes, potatoes, eggplants or peppers as these crops are good hosts for the pathogen.
- If the problem occurs on red raspberries, cut out and destroy infected canes. On black and purple raspberries, dig out and destroy infected plants.
- See Table 4-4 on page 50 for preplanting soil fumigation treatment.

Viruses

Identification

Virus diseases cause various symptoms including leaf curling and puckering and yellow-mottled discoloration known as mosaic. Virus infected plants often produce small crumbly berries and low yields.

Aphids transmit raspberry mosaic and raspberry leaf curl virus from infected to healthy plantings. Dagger nematodes spread tomato ringspot virus.

Symptoms of virus diseases can be confused with similar symptoms from other causes. For example, herbicide injury, poor crop nutrition, root rots or drought cause poor vigour and yellowing or curled leaves. Poor pollination, plant bug injury or a crop nutrition problem can cause crumbly berries.

Monitoring

Leaves of virus-infected plants may not always show virus-like symptoms. Symptoms may appear in the spring and disappear again. The best time to sample plant tissue for virus disease is in the spring, when plants are actively growing. The Pest Diagnostic Clinic at the University of Guelph can diagnose some virus diseases using ELISA test kits (see Appendix E, page 235).

Diagnosis of virus diseases is difficult and should be considered only when other potential causes of the problems have been ruled out.

Management notes

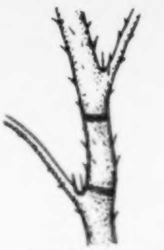
The following steps help minimize the spread of viruses.

- Use virus-tested, disease-free planting stock from an accredited plant propagation program.
- Destroy all nearby wild raspberries and blackberries because these are frequently infected with virus diseases.
- Set new plantings at least 16 m from older plantings to reduce the spread of aphids from one planting to another.
- Black and purple raspberries are very susceptible to virus diseases. To reduce the spread of virus from black and purple varieties to red raspberries, do not plant red raspberries close to purple and black raspberries.
- Rogue out and completely destroy all virus-infected plants as soon as symptoms of mosaic or leaf curl appear.

NOTES ON RASPBERRY INSECTS

Raspberry cane borer

Identification



Shoot Tip Damage from Raspberry Cane Borer

This pest is a slender, dark coloured beetle, about 12 mm long, with antennae as long as its body. It lays eggs in the tips of raspberry primocanes, several inches below the tip. Canes are girdled with 2 zipper-like rings about 15 mm apart. The tip wilts above the point of injury and eventually dries up.

Period of activity

The beetles are active in late June, July and August. Primocanes wilt immediately after egg-laying occurs. The larvae tunnel down the canes and overwinter near the base inside the cane.

Management notes

There are no insecticides labelled for control of this pest.

- Examine canes frequently in June and July for injury.
- Cut off wilted tips below lower ring as they appear and burn them.

Raspberry crown borer

Identification

Affected canes wither and die, or growth is limited and fruit is small. Eventually primocanes are so few in number that the planting dies out.

Raspberry crown borers are 2.5 cm, cream coloured larvae with brown heads. The adult is a clear-winged moth with a wing span of 2.5–3.0 cm. The yellow bands across its black abdomen make it resemble a yellow jacket wasp.

Period of activity

The adult lays its eggs on plant foliage in summer; larvae travel to the base of the cane to overwinter. They do not tunnel into the cane and crown until the following spring. Larvae spend 2 years in the crown and root area before emerging as adults. They burrow at the base of the cane, in larger roots and in the crown. Around harvest time of the 2nd summer, they pupate and emerge from the crown.

Monitoring

- To diagnose this pest dig up crowns and look for larvae, sawdust-like frass and tunnelling. Cut through the crown with clippers or shears to look for larvae.
- Canes growing out of infested crowns can sometimes be pulled or tugged away from the crown, revealing borer damage and frass.

Management notes

Insecticides are targeted at the base of the cane, in fall or early spring, before the larvae tunnel in. Treatment is required for 2 years to break the cycle of this pest.

Raspberry fruitworm

Identification

The raspberry fruitworm adult is a small (approx. 4 mm) light brown beetle covered with short hairs. The larvae are slender, creamy white, approx. 6 mm and found inside the cup of the raspberry fruit.

Period of activity

Adults are active in May and June, as buds emerge. They feed on unfolding leaves and buds on fruiting canes. Their feeding causes elongated long holes in the leaf, which sometimes destroys bud clusters. Larvae are present in developing fruit and are most often observed at harvest.

Monitoring

Watch for leaf feeding around developing fruit buds. Adults can be detected by shaking bud clusters into a dish or tray, but quiet observation is the best way to detect these insects.

Management notes

There are several insecticides recommended for control of this pest, prebloom.

Raspberry sawfly

Identification

Raspberry sawfly adults are tiny (6 mm), stout black wasps. They lay eggs in raspberry leaves. Larvae are bristly and green, and eventually reach 12 mm in length. Larvae are very similar in colour to the leaf, and generally feed on the underside. They feed for approx. 2 weeks, then drop to the ground, where they overwinter in cocoons.

Period of activity

Adult sawflies are present in June and sporadically through the summer. Larvae feed for approx. 2 weeks. There is one generation per year.

Monitoring

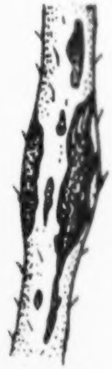
Watch new growth on primocanes for sawfly feeding. Larvae feed mostly between the veins, causing long holes and shredding. In severe infestations, leaves are skeletonized; however, in most cases vigorous raspberry plantings can easily tolerate obvious feeding from sawfly larvae.

Feeding from sawfly larvae is easily confused with feeding from raspberry fruitworm. Raspberry fruit worm beetles tend to be active earlier in the season and feed on developing laterals on fruiting canes. Raspberry sawfly larvae tend to feed on new primocane growth.

Management notes

The pest is easily controlled with insecticides.

Red-necked cane borer



Lump or Swelling in Cane from Red-Necked Cane Borer

Identification

This pest, also known as the rose-stem girdler, is seen occasionally in raspberries in Ontario. The adult beetle is a small (6 mm) dark metallic beetle with a flat head and reddish coloured band just behind the head. The beetle emerges from fruiting canes in late spring or early summer. Eggs are laid on the lower half of the primocanes. Larvae tunnel in a spiral fashion around the cane. The first few spirals under the bark result in a swelling or gall. The larvae continue to tunnel up or down the cane in the pith. Infested canes may wilt or dry up and often break off at the gall.

Period of activity

Adults are active in late June and early July. Larvae tunnel up and down the cane in July and August. Injury is most frequently observed in late summer, fall or winter when infested canes break off about 2–3 feet above the ground.

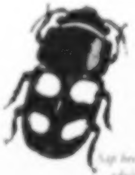
Management notes

There are no insecticides registered for control of this pest. Prune out and remove infested canes before spring.

Sap beetles

Identification

Sap beetles, also called picnic beetles, are 6 mm long, black with cream markings. They are attracted to ripe fruit and infest raspberries in the field and after harvest.



Sap beetle adult

Management notes

No chemical sprays give effective control of sap beetles.

- The pest can be managed by harvesting on a regular basis and removing damaged and diseased fruit as well as healthy fruit.
- Bury compost and trash piles or locate them at a different site.
- Never put boxes of berries on the ground.
- Remove harvested fruit to a screened building or shelter immediately after picking.
- Baits may be used on a small scale to trap beetles. Apple cider vinegar or a mixture of yeast, sugar and water combined with a few drops of liquid detergent will drown the beetles. Commercially prepared bait containing the insecticide carbaryl is available.

SASKATOON BERRY CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Table 8–16. *Days to harvest intervals for products used on saskatoons*, below.

Pest	Product	Rate/ha	Comments
Early bud break			
Saskatoon bud moth Fruit tree leafroller	• Superior "70" Oil	20 L /1,000 L water	Apply in high water volume until all plant surfaces are coated. Do not apply in freezing weather or if frost is expected.
Flower bud break			
Saskatoon-juniper rust	• Funginex 190 EC	3.0 L	Make 1 application of Funginex, between flower bud break and white tip.
Entomosporium leaf and berry spot	• Funginex 190 EC • Kumulus DF	3.0 L 7.5 kg	Make 1 application of Funginex, between flower bud break and white tip. Apply Kumulus at flower bud break and repeat at 10–14 day intervals while disease risk persists. Do not apply if temperatures are over 27°C or leaf injury may result.
White tip			
Saskatoon-juniper rust Entomosporium leaf and berry spot	• Funginex 190 EC • [3]Topas 250E	3.0 L 500 mL	Do not apply Funginex again if application was made at bud break. Apply in at least 200 L of water/ha.
Entomosporium leaf and berry spot	• Kumulus DF	7.5 kg	Repeat at 10–14 day intervals while disease risk persists.
Bloom			
Powdery mildew	• Nova 40W	113 g	Apply in 1,000 L water/ha. Spray until plants are dripping. Apply no more than 340 g/ha per season.
Petal fall			
Saskatoon-juniper rust Entomosporium leaf and berry spot	• [3]Topas 250E	500 mL	Apply in at least 200 L of water/ha.
Green fruit			
Powdery mildew	• Nova 40W	113 g	Apply in 1,000 L water/ha. Spray until plants are dripping. Apply no more than 340 g/ha per season. Repeat application in 10 days if necessary. Maximum 3 applications/season.
Saskatoon-juniper rust Entomosporium leaf and berry spot	• [3]Topas 250E	500 mL	Apply in at least 200 L of water/ha.

TABLE 8–16. Days to harvest intervals for products used on saskatoons

Use this table as a guide, but refer to product label for specific information. The pre-harvest interval is the number of days between the last spray and first harvest.

Product	Preharvest interval (days)
Funginex 190 EC	60
Kumulus DF	1
Nova 40W	14
Superior "70"Oil	Apply no later than 1/4 inch green
Topas 250E	38

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

NOTES ON SASKATOON BERRY INSECTS

Saskatoon bud moth

Identification

Yellow to light green larvae feed on developing buds as buds break open and expand. Tiny holes in the flower buds where insects enter may ooze at the point of injury. Leaves are tied together with webbing and larvae can be found inside.

Period of activity

Bud moth adults are active in early spring and lay eggs on the base of buds and the bark of twigs. Eggs hatch in April and the larvae bore into the base of the bud. The larvae are full grown by petal fall.

Management notes

- Superior oil at bud break will affect egg laying and hatch. Use a high volume of water, ensuring thorough coverage of twigs and buds.

Woolly elm aphid

Identification

The woolly elm aphid, and its close relative the woolly apple aphid, are bluish-white aphids with a white, waxy, wool-like coating. They feed on the roots of saskatoon bushes, 2–10 cm below the soil surface. Infested bushes lack vigour. Leaves turn yellow in late July–August and drop prematurely. Severely affected bushes may fail to leaf out in the spring.

Period of activity

The aphids overwinter on elm trees and migrate to saskatoon bushes in June and July. Aphid colonies are found on roots of saskatoon bushes in July to October.

Management notes

- If practical, remove wild apple and elm trees in the vicinity.

NOTES ON SASKATOON BERRY DISEASES

Entomosporium leaf and berry spot

Identification

This is the most serious disease of saskatoons. Small angular brown spots first develop on lower leaves and eventually cause leaves to yellow. Lesions may also develop on the petioles, causing leaf drop. Infected fruit have small grey, lesions and become disfigured and cracked.

Period of activity

The fungus overwinters on fallen leaves and twigs. New infections are favoured by rain in the spring and early summer.

Management notes

- Adjust plant density and pruning practices to provide adequate airflow through the row.
- Control weeds in the row and use trickle irrigation rather than overhead sprinklers.
- Several fungicides are labelled for control of this disease. See page 139.

Saskatoon-juniper rust

Identification

Early symptoms include yellowish spots and swellings on leaves and fruit. Older infections develop spiky outgrowths. On juniper, the fungus appears as woody round galls. Jelly like horns grow out of these galls in the spring following a rain.

Period of activity

Jelly like horns on juniper galls produce spores that can spread to saskatoons up to 2 km away. The disease is favoured by cool wet spring weather.

Management notes

- Prune out rust galls or remove entire juniper plants in the immediate vicinity of the orchard to reduce disease pressure.
- See page 139 for fungicides that are labelled for control of this disease.

STRAWBERRY CALENDARS

Management Practices to Reduce Pesticide Use

Use these techniques to suppress pest populations.

Diseases & Insects	Management Practice	Comments
Between plantings		
White grub Wireworm	Crop rotation	Consider cultivated row crops such as snap beans, white beans, cabbage, broccoli, brussels sprouts and cauliflower. Avoid preferred hosts such as corn, grasses, cereal species and potato.
Root lesion nematode White grub Root weevil Wireworms Annual and perennial weeds Two-spotted spider mite	Summer fallowing	Cultivate to 10 cm depth, frequently enough to kill young weeds and discourage weed growth. Avoid this practice on sloping land prone to erosion. Sow oats or spring wheat in September as a cover crop to minimize soil erosion by wind and water. Do not use cereal rye, because this encourages nematodes. For more details on preplant weed control, consult OMAF *Publication 75, Guide to Weed Control.* See *Site Preparation* and *Special Methods of Weed Control* sections.
Before planting		
Verticillium Red stele Leather rot Black root rot	Site selection Crop rotation	Select a site with good soil drainage. Avoid heavy, poorly drained soils. Avoid sites with a history of red stele and verticillium. Avoid growing susceptible crops before planting strawberries. Susceptible crops that favour build-up of verticillium in the soil include potato, tomato, peppers, eggplant and alfalfa.
Botrytis fruit rot Leaf scorch Leaf spot Leaf blight	Site selection	Select a planting site with good air drainage. Expose plants to direct sunlight and plant rows parallel to the direction of the prevailing winds to promote fast drying of foliage and fruit.
Root weevil Cyclamen mite	Isolation	Isolate new plantings from older infested plantings to provide a physical barrier to reduce land migration of these pests.
Red stele Verticillium	Cultivar selection	Choose varieties that have some resistance to the red stele fungus *Phytophthora fragariae* and verticillium. See Table 8–18, *Strawberry variety disease ratings*, on page 150 for more information. Use only plants that have been grown under the guidelines of an accredited plant propagation program.
Harvesting years, late April to early May		
Plant bugs Spittle bug Two-spotted spider mite Botrytis fruit rot Leather rot	Weed control	Broadleaf weeds provide alternate hosts and encourage the build up of plant bug and two-spotted spider mite populations. Grassy fencerows or volunteer grass in the planting provide alternate hosts and build up of spittlebug populations. Weeds keep relative humidity high and prolong leaf wetness, which encourages fruit rots.
Harvesting year, mid to late May		
Leather rot	Straw mulch	Apply straw mulch, thick enough to prevent soil from splashing onto berries, at petal fall and prior to significant berry formation.
Botrytis fruit rot Leather rot Black root rot	Fertilization	Avoid excessive fertilization that can encourage too much foliar growth, creating a dense, humid canopy.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases & Insects	Management Practice	Comments
Preharvest to harvest		
Botrytis fruit rot Leather rot Black root rot Verticillium Red stele	Irrigation scheduling	Irrigate for short periods to allow foliage and fruit to dry out before nightfall. Do not apply too much water at one time. Avoid creating puddles.
Renovation (early July)		
Two-spotted spider mite Powdery mildew	Mowing	Mow off strawberry leaves to eliminate the food source for these pests, and reduce the population.
Botrytis fruit rot Leather rot	Narrowing rows	Narrow the width of matted row to 30 cm to decrease plant density and encourage airflow and quick drying of the crop canopy. Incorporate plant crop residues into the soil and rototill to destroy the main source of botrytis. If runnering is too vigorous, narrow the rows again in October using a coulter.
Renovation		
Black root rot	Subsoiling	Subsoiling in late July or August reduces compaction and improves soil drainage.

STRAWBERRY CALENDAR (NON-BEARING)

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage.

Diseases and Insects	Materials	Amount/ha	Comments
Early June			
Strawberry leafroller	• [9]Guthion Solupak or [9]Sniper • Malathion 25 W	1. 12 kg 1.12 kg 4.25 kg	
One month after planting and again once or twice at 2 week intervals			
Leaf blight Leaf scorch Leaf spot	• Copper 53W • Equal 65WP • [4]Supra Captan 80 WDG or [4]Maestro 80 DF	3.80 kg 1.75 kg 4.25 kg 4.25 kg	Good coverage of lower leaf surface is essential for control of leaf spot. Copper, Captan and Maestro are labelled for leaf spot only. Spray susceptible varieties such as Bounty, Kent, Veestar, Tristar, Micmac and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays see *Use of Copper Products on Fruit Crops* on page 54. Equal may injure plants under cold weather conditions. Alternate fungicides from different chemical families to reduce the risk of resistance developing. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
July to mid-August			
Potato leafhopper	• Malathion 25 W	4.25 kg	Check underside of leaves and spray when nymphs are present. Repeated applications may be necessary for leafhopper control.
Fall			
Red stele	• [2]Ridomil Gold 480 EC • Aliette WDG	1.00 L 5.60 kg	To reduce the chance of resistance developing, spray only where red stele has been observed and confirmed. **Ridomil Gold:** Make 1 application in early September and a 2nd treatment in late October, but no later than October 31. Apply in sufficient water (2,500 L/ha) to ensure movement into the root zone. **Aliette:** Make a maximum of 4 applications/season, 2 in spring and 2 in fall. Apply as a foliar spray in spring when plants start active growth. Apply at 30–60 day intervals. Make fall applications when soil conditions favour disease development (e.g., high soil moisture, cool temperatures).

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

STRAWBERRY CALENDAR (FRUITING YEARS)

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. See Table 8–17. *Days to harvest intervals for products used on strawberries*, on page 146.

Diseases and Insects	Materials	Amount/ha	Comments
When new growth appears			
Botrytis grey mould	• [4]Bravo 500	3.50 L	Bravo helps control botrytis by reducing disease inoculum and preventing infection of dying leaves. Repeat application in 10 days.
When flower buds are visible in the crown			
Leaf blight Leaf scorch Leaf spot	• Copper 53 W • Equal 65 WP • [4]Supra Captan 80 WDG or [4]Maestro 80 DF	3.80 kg 1.75 kg 4.25 kg 4.25 kg	Captan, Maestro and Copper are labelled for leaf spot, but not leaf scorch. Good coverage of the lower leaf surface is essential for leaf spot control. Spray susceptible cultivars such as Bounty, Kent, Veestar, Micmac, Tristar and Tribute. Spray copper alone. For instructions on mixing copper sprays, see *Use of Copper Products on Fruit Crops* on page 54. Equal may injure plants under cold weather conditions.
Cyclamen mite	• Thiodan 50WP or Endosulfan 50W or Thiodan 4 EC	4.00 kg 4.00 kg 5.00 L	Apply one of these chemicals in 4,000–8,000 L of water/ha as a drench over the plant row.
As flower buds extend from crown			
Strawberry clipper weevil	• [4]Furadan 480F • Cymbush 250EC or Ripcord 400EC • [3]Matador 120EC	1.10 L 280 mL 175 mL 104 mL	Check edges of fields for clipped buds. Apply insecticide when 1st injury is detected. A 2nd application may be required if new injury is detected 7 days after the first spray. Do not use Furadan later than pre-bloom because of its toxicity to pollinating and beneficial insects. Use Furadan only once during the season. Note: Furadan can cause extensive burning of sepals surrounding fruit on certain varieties (e.g. Annapolis, and Cavendish).
First bloom			
INSECTICIDES ARE VERY TOXIC TO BEES. DO NOT SPRAY WHEN BEES ARE WORKING. SPRAY IN THE EVENING. SEE BEE POISONING ON PAGE 64.			
Plant bugs	• Cygon 480-Ag • Cymbush 250EC or Ripcord 400 EC • Decis 5 EC • [3]Matador 120 EC • Thiodan 50WP	2.75 L 400 mL 250 mL 200 mL 104 mL 2.00 kg	Cymbush, Ripcord, Matador or Decis also control clipper weevil. Thiodan, Cymbush, Ripcord, Matador or Decis also control spittlebug.
Botrytis grey mould	• [2]Rovral • [1]Elevate 50 WDG • [4]Supra Captan 80WDG or [4]Maestro 80 DF • Folpan 50 WP • [5]Ronilan EG • [1]Lance WDG	2.00 kg 1.70 kg 4.25 kg 4.25 kg 4.00 kg 2.00 kg 560 g	Keep all flower parts protected with fungicide during bloom for good control of botrytis. Typically 2–3 sprays during bloom will give good control. Shorten intervals to 3–5 during wet weather. Use Rovral, Ronilan, Elevate or Lance when disease pressure is high. Choose fungicides from different chemical families and use them in rotation. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
Anthracnose	• [3]Cabrio EG	1.00 kg/ha	Make no more than 2 consecutive applications, then alternate with fungicides from different families. See Table 4–2 on page 47. Bloom is the best time to control this disease. Warm wet weather during bloom favours the development of anthracnose.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
7 to 10 days after first bloom			
Plant bugs	• Cymbush 250EC or Ripcord 400 EC • Decis 5 EC • [3]Matador 120 EC • Thiodan 50WP	400 mL 250 mL 200 mL 104 mL 2.00 kg	
Botrytis grey mould	• [2]Rovral • [1]Elevate 50 WDG • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Folpan 50 WP • [5]Ronilan E G • [1]Lance WDG	2.00 kg 1.70 kg 4.25 kg 4.25 kg 4.00 kg 2.00 kg 560 g	Shorten intervals to 3–5 days if wet weather persists. Use Rovral, Ronilan, Elevate or Lance when disease pressure is high. Alternate with fungicides from different families. See Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
Anthracnose	• [3]Cabrio EG	1.00 kg	Make no more than 2 consecutive applications, then alternate with fungicides from different families. See Table 4–2 on page 47. Warm wet weather during bloom favours the development of anthracnose.
Preharvest			
Slugs	• Sluggo	25 kg	Apply 50 kg/ha if population is very high. Apply when infestation begins. Reapply as bait is consumed, or at least every 2 weeks if slugs and snails continue to be a problem.
Two-spotted spider mite	• [3]Pyramite • Kelthane 50W • Apollo SC	600 g 2.00 kg 500 mL	Coverage of the underside of leaves is essential for good control. Use high water volumes. To discourage resistance, alternate products from year to year, and do not apply any product more than once each year. **Apollo**: Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are developing, mostly in the egg stage.
Botrytis grey mould	• [2] Rovral • [1]Elevate 50 WDG • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Folpan 50 WP • [5]Ronilan EG • [1] Lance WDG	2.00 kg 1.70 kg 4.25 kg 4.25 kg 4.00 kg 2.00 kg 560 g	If irrigation is necessary, water early in the day to allow plants to dry off before nightfall.
Anthracnose	• [3]Cabrio EG	1.00 kg/ha	Make no more than 2 consecutive applications, then alternate with fungicides from different families. Warm wet weather during bloom favours the development of anthracnose.
Renovation (after mowing)			
Cyclamen mite	• Thiodan 50WP or Endosulfan 50W or Thiodan 4 EC	4.00 kg 4.00 kg 5.0 L	Apply one of these chemicals in 5,000–8,000 L of water/ha as a drench over the plant row.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Renovation (after mowing, to new growth)			
Two-spotted spider mite	• [3]Pyramite • Kelthane 50W • Agrimek 1.9% EC • Apollo SC	600 g 2.00 kg 1.00 L 500 mL	Coverage of the underside of leaves is essential for good control. Use high water volumes. To discourage resistance, alternate products from year to year, and do not apply any product more than once each year. **Apollo**: Apollo kills mite eggs and very young nymphs, but not older nymphs and adults. Apply when monitoring indicates mites are beginning to hatch or are mostly in the egg stage. **Agri-Mek**: Use postharvest only.
Fall			
Botrytis grey mould	• [4]Bravo 500	3.50 L	Bravo helps control botrytis by reducing disease inoculum. Apply late October.
Leaf blight Leaf scorch Leaf spot	• Copper 53W • Equal 65WP • [4]Supra Captan 80 WDG or [4] Maestro 80 DF	3.80 kg 1.75 kg 4.25 kg 4.25 kg	Copper is labelled only for leaf spot. Spray susceptible varieties such as Bounty, Kent, Veestar, Micmac, Tristar, and Tribute. Spray copper sprays alone. For instructions on mixing copper sprays see *Use of Copper Products on Fruit Crops* on page 54. Equal may injure plants in cold weather. Alternate between copper and Equal to reduce the development of resistance. Good coverage of the lower leaf surface is important for leaf spot control.
Red stele	• [2]Ridomil Gold 480 EC • Aliette WDG	1.0 L 5.60 kg	To reduce the chance of resistance developing, spray only where red stele has been observed. Apply in sufficient water (2500 L/ha) to ensure movement into the root zone. Do not apply Ridomil Gold later than October. 31 or in the spring on established plants. With Aliette, make a maximum of 4 applications per season, 2 in spring and 2 in fall. Apply in spring when plants start active growth. Apply at 30–60 day intervals. Do not apply within 30 days of harvest, or after 1st bloom. Make postharvest applications when soil conditions favour disease development (e.g., high soil moisture and cool soil temperatures).

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FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 8–17. Days to harvest intervals for products used on strawberries

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the number of days between the last spray and first harvest

Product Name	Preharvest interval (days)
Agri-mek 1.9%EC	300 days (10 months)
Aliette WDG	30
Apollo SC	15
Bravo 500	30
Cabrio EG	1
Supra Captan 80 WDG	2
Copper 53W	1
Cygon 480-Ag	7
Cymbush 250 EC	7
Decis 5 EC	14
Elevate 50 WDG	1
Endosulfan 50 W	7
Equal 65 WP	7
Folpan 50 WP	1
Furadan 480 F	Use prebloom only
Kelthane 50W	7
Lance WDG	0
Maestro 80 DF	2
Malathion 25W	3
Matador 120 EC	7
Pyramite	10
Ridomil Gold 480 EC	Use postharvest only
Ripcord 400 EC	7
Ronilan EG	3
Rovral	1
Thiodan 4EC	7
Thiodan 50 WP	7

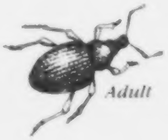
NOTES ON STRAWBERRY INSECTS

Monitoring methods and thresholds have been established for several strawberry pests. See the following OMAF Factsheets and information sources:

- Order No. 92-108, *Tarnished Plant Bug*
- Order No. 99-031, *Strawberry Clipper Weevil*
- Publication 513, *Growing Strawberries in Ontario.*

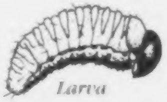
Root weevils

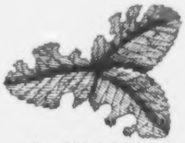
The black vine weevil, the strawberry root weevil and the rough strawberry root weevil are all strawberry pests.



Identification

Weevil larvae, or grubs, feed on strawberry roots. They are about 1 cm long, with cream-coloured, legless C-shaped bodies and brown heads. They are generally smaller than white grubs. Adults weevils are identified by their characteristic long, probing mouthpart called a snout. The adults are wingless and migrate by crawling across land. They feed at night, chewing C-shaped notches on edges of strawberry leaves.





Leaf Notching from Root Weevil Feeding

Period of activity

Root weevils overwinter as larvae in soil. In late fall and spring, these larvae feed on strawberry roots causing plants to be stunted and die. Adults begin to emerge from the soil during harvest. Adults are in the field throughout July and early August, when they feed and lay eggs on strawberry leaves. Peak emergence and egg laying by adults occurs in July after harvest is completed. When the eggs hatch, larvae move into the soil to feed on fine rootlets and overwinter. Root damage is not usually evident until the following spring. Although there is only one generation a year, populations can build rapidly, within 2 years of planting.

Management notes

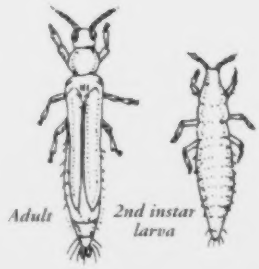
- Till the soil between the strawberry rows at renovation to expose root weevil populations and reduce their numbers.

- Do not establish new plantings near older, infested plantings.
- There are no insecticides labelled for root weevil control. When insecticides are applied for control of strawberry clipper weevil, they suppress existing root weevil populations by killing early emerging adults and some larvae that may still be feeding. However, this timing is too early to kill the majority of emerging adults and too late to kill most larvae which have already finished feeding on the roots.
- Beneficial nematodes have been used in some regions in an attempt to control root weevil larvae. Research on these and other control strategies is in progress across Canada.

Thrips

Identification

Thrips are tiny, yellow insects, long and narrow in shape, and less than 2 mm long. They begin feeding in the bloom. As the berry grows and seeds separate, they begin feeding on the fruit. Symptoms of fruit bronzing occur when king berries reach 5–10 mm in diameter. Close inspection of strawberry fruit reveals a necrotic flecking or bronzing of the seeds and fruits, especially beneath the calyx. The entire fruit may become bronzed and cracked.



Most fruit bronzing is caused by flower thrips. Cyclamen mites and two-spotted spider mites can also cause bronzing.

Period of activity

Thrips do not overwinter in Ontario but migrate each spring on air currents from the south. They are attracted to white flowers and therefore to strawberry bloom that is open when the thrips arrive. They do not cause problems on strawberries every year.

Monitoring and thresholds

- Shake blossom clusters into a white tray or dish. If high numbers of yellow thrips appear, check developing fruit for injury.
- Use a hand lens to look under the calyx of small green fruit for thrips and rusty discolouration.
- Specific monitoring techniques and control strategies for thrips have not been worked out in Ontario.

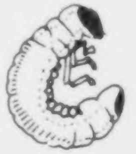
Management notes

There are no registered insecticides for thrips. Insecticides applied for control of strawberry clipper weevil and tarnished plant bug also suppress thrips.

White grubs

White grubs are the immature stage of scarab beetles, including June beetle, European chafer and Japanese beetle.

Identification



The larvae are C-shaped, with a tan or brown head capsule and 6 prominent spiny legs. These beetles usually lay their eggs in sod or other grassy places. The eggs hatch into larvae or white grubs that feed on plant roots. Symptoms of white grub injury o strawberry plants include stunted growth and pruned roots. Damage is most common in lighter soil types when strawberries are grown after pasture, sod or occasionally, a grassy crop.

Period of activity

June beetle adults are active in late May and early June, European chafer adults are active in June, Japanese beetle adults are active in June and July. Eggs are laid in grassy places. The eggs hatch into larvae, or white grubs, and feed on plant roots. Feeding by European chafer larvae and Japanese beetle takes place in late summer and again in the spring, until adults emerge. June beetle larvae remain in the soil for 3 seasons, feeding on plant roots throughout each growing season.

Management notes

There are no insecticides registered for white grub control on strawberries.

- Do not establish new plantings for 2 years after sod or pasture crops. Keep grassy weeds under control to make the habitat less favourable for white grubs.
- Grass parking lots can serve as a large reservoir for the build-up of grubs. Treat these grass areas like

turf or lawns but do not treat inside the planting. If 5 grubs per 1/10th of a square metre (1 ft.^{2}) are found, treat with insecticide labelled for turf.

- For more information on white grubs refer to OMAF Factsheet *Grubs in Lawns*, Order No. 97-023.

NOTES ON STRAWBERRY DISEASES

Angular leaf spot

Identification

Symptoms of angular leaf spot develop on the leaves and the fruit calyx. Tiny angular spots are first evident on the lower leaf surface. The spots look wet when viewed from above, but are translucent when held up to the light. Bacteria ooze out of these spots in humid weather. When the ooze dries up, it leaves white flaky residue. Infected sepals turn black, making fruit unmarketable. This disease can be systemic on the plant; sometimes it causes plants to collapse.

Period of activity

Disease pressure is highest where frost has been frequent during bloom and overhead irrigation has been used to protect against frost. Cool spring conditions with frequent rainy periods are ideal for the development and spread of this disease. Symptoms are expressed in warm humid weather.

Management notes

Angular leaf spot is a bacterial disease and is not controlled by fungicides.

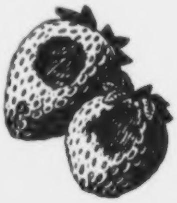
- Avoid excessive irrigation for frost protection.
- Avoid excessive nitrogen because young leaf tissue and leaves on very vigorous plants are more susceptible.
- Clean up crop debris, especially on plastic-mulched beds.
- Avoid working in fields when they are wet.

Certain varieties are more susceptible than others (Table 8–18, *Strawberry variety disease ratings*, on page 150) but if disease pressure is high all varieties can become infected.

Anthracnose fruit rot

Identification

Brown or black sunken circular lesions develop on green or ripe fruit. Salmon-coloured spore masses ooze from these lesions in humid conditions. Distinct, dark, sunken lesions may form on petioles and runners, and crowns. These lesions may cause daughter plants to die, outer leaves to die prematurely, or the plant may collapse from crown rot. Certain varieties, i.e. G19, seem to be very susceptible.



Period of activity

The disease overwinters on infected plant debris. Spores may be present on symptomless plants. These spores are spread by rain-splash to bloom and fruit. Spores may also be spread on equipment and workers.

Even though spores may be present, anthracnose outbreaks are very weather dependent. Infection is favoured by splashing rains, and warm humid weather, especially close to harvest. Day-neutral varieties, and plants grown in plasticulture systems are more likely to be exposed to these conditions and are at higher risk of anthracnose than June-bearing varieties in matted rows.

Management notes

- Purchase plants from an accredited program.
- Remove infected fruit from the field during harvest.
- Work in infected fields last.
- Use straw mulch to reduce rain splash.
- Clean up crop debris between crops.

- Vigorous plants high in nitrogen seem to be more susceptible to this disease, so avoid over-use of nitrogen.
- Fungicides can be used to help manage this disease.

Leather rot

Identification

Leather rot can infect strawberry bloom, green fruit or mature fruit. Infected blossom clusters turn brown and die. Green fruit become hard and leathery. Leather rot symptoms are most often noticed on ripening fruit. Ripe fruit develop a purplish colour and a foul odour and taste.

Period of activity

Leather rot is caused by *Phytophthora*, a fungus that lives in the soil. Infection can take place anytime between bloom and harvest, if spores are splashed or washed onto bloom or fruit. Leather rot is worse under cool, wet, harvest conditions.

Management notes

- Use a thick layer of straw mulch between the rows to prevent berries from touching the soil and soil from splashing to fruit.
- Ensure fields are well drained and prevent standing water.
- Some fungicides used for botrytis control will reduce the incidence of leather rot, although none are registered for the control of this disease. Rovral, Ronilan and Benlate do not control leather rot.

Nematodes

Nematodes are microscopic wormlike creatures that live in soil and feed on strawberry roots. They can cause stunting of plant growth, and make plants more susceptible to verticillium infection. Strawberries have a lower threshold than many other fruit crops for root lesion nematodes. Nematodes must be controlled before planting. For more information on nematodes and control, refer to *Nematodes in Berry Crops* on page 49.

TABLE 8–18. Strawberry variety disease ratings

	Leaf Spot	Leaf scorch[6]	Powdery mildew	Botrytis rot	Verticillium	Red stele[1][*]	Bacterial angular leaf spot[4]
Allstar[2]	MR[*]	S	MR	MR	MR	S	HS
Annapolis	MR	MR	S	S	MR	R	HS
Aromas	MS	?	MR	?	S	?	?
Bounty	MR	MR	MR	MR	HS	R	S
Brunswick	MR	MR	MR	MR	?	R	?
Cabot	MR	MR	R	S	S	R	?
Cavendish	MR	R	S	MR	MR	R	HS
Chambly	R	MR	R	?	?	S	?
Evangeline	MR	R	MR	MR	S	S	?
Glooscap	MR	MR	MR	S	S	S	S
Gov. Simcoe	MR	MR	HS	MR	MR	S	S
Honeoye	MR	MR	MR	MR	HS	S	HS
Jewel[3]	HR	MR	HR	MR	S	S	HS
Kent	HS	S	MR	S	S	S	HS
Micmac	S	HS	MR	S	MR	S	S
Mira	S	R	R	MR	S	R	S
Mesabi[8]	R	R	MR	S	?	R	?
Mohawk[5]	?	MR	MR	?	?	MR	?
Redcoat	MR	MR	MR	HS	S	S	S
Sable	R	R	S	S	?	R	HS
St. Pierre[7]	MR	S	MR	R	?	S	?
Sapphire	?	MR	MR	?	?	?	?
Scotland	MR	R	MR	MR	MR	?	?
Seascape	?	?	HS	?	?	?	?
Settler	MR	MR	HS	MR	MR	?	S
Serenity	?	MR	MR	?	?	?	?
Sparkle	S	MR	MR	MR	S	HR	S
Startyme	S	S	S	?	?	?	?
Tribute	MR	MR	S	MR	R	MR	?
Tristar	MR	MR	S	MR	R	MR	MR
Vantage	R	R	R	MR	R	R	S
Veestar	S	MR	S	MR	MR	S	MR
Winona[8]	R	MR	MR	?	?	R	HS
Yamaska	R	R	R	?	R	?	?

HR — Highly Resistant; **R** — Resistant; **MR** — Moderately Resistant; **S** — Susceptible; **HS** — Highly Susceptible

? Unknown

[*] Race Dependent

[1] Red stele ratings from Dr.N. Nickerson and Dr. A.Jamieson, Agriculture & Agri-Food Canada, Kentville, Nova Scotia

[2] Gene Galletta, USDA, Maryland, (1991)

[3] Marvin Pritts, Cornell, N.Y. (1991)

[4] Pers. Comm. G. Braun, Agriculture & Agri-Food Canada, Kentville, Nova Scotia, 2003 and field observation

[5] Galletta, Mass, Enns & Draper, 1995

[6] Leaf scorch ratings according to Xue, Sutton, Dale, and Sullivan 1996, for some cultivars

[7] Shahrokh Khanizadeh, HortScience 37(7) 2002

[8] University of Minnesota Extension, 2002

TABLE 8–19. Effect of fungicides on strawberry diseases

Use fungicides only for diseases listed on the label.

	Aliette (fosetyl-al)	Benlate (benomyl)	Bravo (chlorothalonil)	Cabrio (pyraclostrobin)	Captan and Maestro (captan)	copper	Elevate (fenhexamid)	Equal (dodine)	Folpan (folpet)	Lance (boscalid)	Ridomil (metalaxyl)	Rovral (iprodione)	Ronilan (vinclozolin)	sulfur
Angular leaf spot	0	0	0	0	0	+P	0	0	0	0	0	0	0	0
Anthracnose *(C. acutatum)*	0	0?	?	+++	++	+P	0	0	++	?	0	0	0	0
Anthracnose *(C. gloeosporioides)*	0	+R	?	+++	++	+P	0	0	++	?	0	0	0	0
Botrytis grey mould	0	++R	++	+ to ++	++	+P	+++	0	++	+++	0	+++R	+++R	0
Common leaf spot	0	++	+	++++	+++	+P	?	++ R	+++	+++	0	++	++ to +++	0
Leather rot	++	0	?	0	+	+P	0	0	+	0	++	0	0	0
Leaf scorch	0	++	+	++	?	+P	0	++R	?	?	0	?	?	0
Phomopsis leaf blight and fruit rot	++	++	+	?	+ to ++	+P	0	?	+ to ++	?	0	0	?	0
Phytophthora crown rot	++	0	0	0	0	0	0	0	0	0	++ to +++	0	0	0
Powdery mildew	0	+R	?	+++	0	+P	0	0	0	++	0	0	0	++P
Red stele root rot	++	0	0	0	0	0	0	0	0	0	++ to +++	0	0	0

* Use fungicides only for control of diseases listed on the product label

0 = no control; + = poor to fair control; ++ = good control, some limitations; +++ = excellent control, few if any limitations

R — pathogen resistance (insensitivity) to the fungicide has occurred in some locations

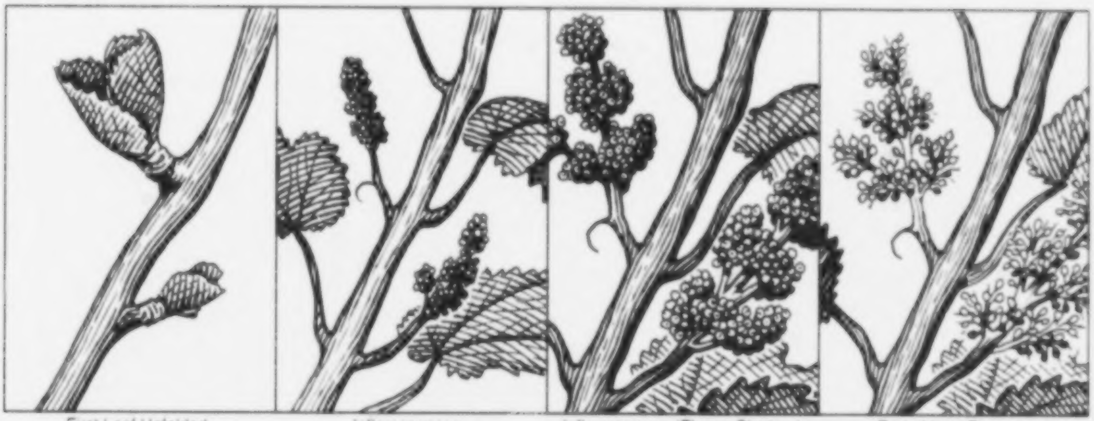
P — may be phytotoxic

? — suspected level of control, needs confirmation.

Source: Based on information developed by the IR4 Project at the annual Small Fruit Workers Meeting, August 1999 and updated by W. McFadden-Smith, McSmith Research Services

9. Grapes

FIGURE 9-1. Grape growth stages

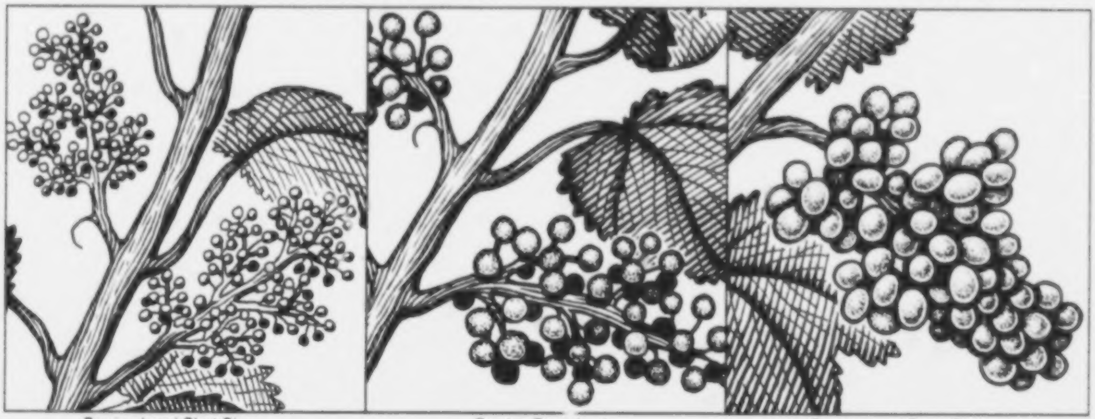


First Leaf Unfolded

Inflorescences (Flower Clusters) Visible

Inflorescences (Flower Clusters) Fully Developed

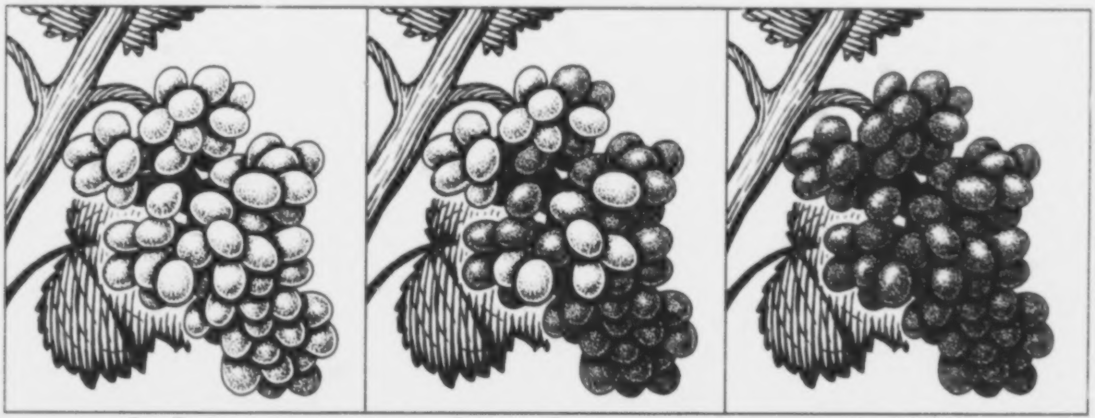
End of Late Flowering to Fruit Set



Berries Lead Shot Size

Berries Pea-sized

Beginning of Berry Touch



Berry Touch

Beginning of Ripening

Late Stage of Ripening

GRAPE NUTRITION

It is important to prepare and test soil before planting vines. Prepare the soil well in advance of planting by tilling and adding organic matter to ensure long-term productivity of these perennial crops. For information on building and maintaining soil organic matter see *Managing Organic Nutrient Additions* on page 30 and *Manure for Vineyards* below.

Prior to planting, ensure that nutrient levels and pH are adequate. Test the soil and apply fertilizer and lime if necessary. See *Fertilizer for Grapes* on page 155. Pre-plant applications of phosphorus, potassium and lime work best.

Manure for Vineyards

Applying manure in the spring provides nutrients and organic matter to established vineyards. Manure can also be applied in the fall prior to new spring plantings.

- Broadcast manure at no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 t/ha of cattle (100 m^3 liquid) or 35 t/ha hog (65 m^3 liquid). The nutrient content of manure varies considerably, so analyze its content before applying.
- When using manure, reduce the rates of nitrogen, phosphorus and potassium fertilizers. Table 3–5, *Average amounts of available nutrients for different types of manure*, on page 31 shows the average composition of some manure and the suggested reduction of fertilizer when using manure.
- For more information about food safety and environmental impacts when applying manure, refer to *Environmental concerns with manure* on page 32 and *Food safety concerns with manure application and timing* on page 33.

Nitrogen from manure is mineralized over a long time, supplying perennial crops with nitrogen during the year. This may result in poor fruit colour, excessive terminal growth and delayed hardening of the woody tissue and could make plants more susceptible to winter injury.

- Do not use manure around newly planted vines because of the potential for winter injury.

pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. To determine pH, take a soil sample. See *Soil Testing* on page 25 for more information.

- Always sample soil before establishing a new planting. The preferred pH before establishing a new vineyard is 6.5 on sandy soils and 6.0 on clay soils. If lime is required, incorporate during soil preparation.
- In established vineyards sample soil in the vine row every 3 years to ensure the pH is satisfactory. If pH is low (acidic), apply lime in the fall to the sod cover or before spring cultivation. The results will not be immediately evident because lime moves slowly into the soil.
- Apply lime to established vineyards when the pH on clay loam soils drops below 5.1 and on sandy soils if below 5.6. Lime raises the soil pH, reducing its acidity and also supplying calcium.
- Use dolomitic lime (high in magnesium) on soils low in magnesium. Application rates vary with soil type and initial pH. The buffer pH indicates the rate of lime to apply. For information on lime, see *Soil Acidity and Liming* on page 28.

Petiole Analysis for Grapes

In established plantings, the best method of determining nutrient needs in grapes is petiole analysis. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop. Petiole analysis, in conjunction with soil analysis, ensures good information on fertilizer and lime needs. For more information on these tests consult *Plant Analysis* on page 26.

Nutrient uptake is affected by many vineyard conditions. Nutrient levels vary each year, depending on the season. In order to obtain optimum growth and fruit quality, adequate levels of all nutrients must be present in the petioles and the relative amounts must be balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. More information is available in OMAF Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

- For petiole analysis to be most effective, sample the same vines each year.

TABLE 9–1. Nutrient level range (% dry weight) of grape petioles (taken in September from mature vines)

Petiole Analysis	Nitrogen		Potassium*		Magnesium
	Low if below	High if above	Low if below	High if above	Low if below
GRAPE					
Vinifera	0.8	1.4	1.2	2.3	0.6
Fredonia	0.6	1.2	0.8	1.8	0.6
Other cultivars	0.7	1.3	1.0	2.0	0.6

* Potassium levels will be higher with grapes grown on sandy loam soils.

TABLE 9–2. Magnesium foliar sprays

Timing	Product	Rate	Notes
3 sprays spaced 10 days apart beginning in mid July	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet plant to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

- Make adjustments to the fertilizer program on the basis of this petiole analysis. For nutrient level ranges determined by petiole analysis, consult Table 9–1, *Nutrient level range (% dry weight) of grape petioles.*

In addition to petiole analysis, consider the system of soil management, vine age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered in determining the fertilizer required.

Fertilizer for Grapes

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Nutrient levels in the topsoil adequate for vineyard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium, and 1,000–5,000 ppm calcium. Table 9–3, *Phosphorus and potassium soil requirements before planting grapes,* on page 156 provides information on fertilizer rates prior to planting.

If the soil is properly prepared, including cultivating deeply and adding organic matter, there should be an adequate supply of other nutrients to sustain the vine in the juvenile years.

- On coarse-textured, infertile soils use a starter solution at planting time of 10-52-10 or 20-20-20.
- High nitrogen levels can result in excessive growth and incomplete vine hardening. Use cover crops to check late season growth in cultivated vineyards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil, checking vine growth.

Nitrogen (N)

- Use petiole analysis to determine nitrogen requirements of grapes. Without such information, 34 kg nitrogen per hectare is usually sufficient for most cultivars.
- Broadcast before the 1st cultivation or apply as early as possible in the spring in sod vineyards.
- Nitrogen application can be reduced or eliminated if manure is used or growth has been excessive. For more information on manure, see *Manure for Vineyards* on page 154. Consult Table 9–1 for petiole analysis values.
- Based on vine performance and petiole analysis, consider foliar applications of nitrogen in some years.

If severe winter temperatures cause fruit bud damage, it may be necessary to split applications.

- Apply the 1st application in mid-April and the 2nd application, if necessary, after bloom in late May.
- Excessive spring rains can leach away spring-applied nutrients. Apply additional fertilizer or foliar sprays after bloom.
- During dry springs, irrigate if necessary to move the fertilizer into the rooting zone of the soil just before 1st bloom or immediately after petal fall.

Phosphorus (P)

Grapes do not require last amounts of phosphorus. With few exceptions, the present level of phosphorus in Ontario soils is adequate. Phosphorus is necessary for sod or cover crop maintenance.

- Use a soil test to determine the need for phosphorus. If a soil test indicates the need, apply phosphorus before planting a vineyard, when it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for establishing and producing a vineyard.

Potassium (K)

- Use a soil test to determine the amount of potassium required. An excess of potassium can lead to deficiency of magnesium (Mg); avoid unnecessary potassium applications. Grapes require a larger quantity of potassium than tree fruits.

TABLE 9–3. Phosphorus and potassium soil requirements before planting grapes

Soil phosphorus		Soil potassium	
New plantings of grapes*		New plantings of grapes*	
Soil test (ppm P)	Phosphate (P_2O_5) req'd kg/ha	Soil test (ppm K)	Potash (K_2O) req'd kg/ha
0–3	80 L	0–15	270 L
4–5	60 L	16–30	270 L
6–7	50 L	31–45	270 L
8–9	40 M	46–60	270 L
10–12	20 M	61–80	270 L
13–15	0 H	81–100	270 L
16–20	0 H	101–120	270 L
21–25	0 VH	121–150	270 M
26–30	0 VH	151–180	270 M
31–40	0 VH	181–210	270 M
41–50	0 VH	211–250	270 H
51–60	0 VH	250 +	270 H
61–80	0 E		
80 +	0 E		

* For established grapes, plant analysis is used to estimate requirements of N, P and K

- In cultivated vineyards, broadcast potassium before the 1st cultivation in the spring. With grapes on clay soils, apply potassium in a band to reduce potassium fixation in the soil. Potash can injure roots and trunks if applied too closely to the trunk.

Foliar application of potassium for grapes

In dry growing seasons potassium is not readily available to the plant. Where a potassium deficiency exists, foliar applications of potassium may help. Foliar potassium applied at veraison may improve fruit yield and quality.

Magnesium (Mg)

Magnesium soil test values between 100–250 ppm are considered adequate for grapes. Dolomitic limestone can be used on acidic soils to raise the soil pH and to supply magnesium. Magnesium deficiency is becoming more evident in vineyards, particularly when high rates of potash are used.

Magnesium deficiency can lead to premature fruit drop at harvest. Because magnesium is a part of the chlorophyll molecule, magnesium deficient vines have older leaves that are pale in colour. Petiole analysis is the best way to evaluate magnesium levels.

Foliar sprays of magnesium correct this deficiency for the current year only. For long-term corrections, apply magnesium to the soil. The response will not likely be immediate. On some soil types a single, early-spring application of soil applied magnesium has not worked well. A 2nd or 3rd application the following spring may be required before the magnesium level in the plant improves.

Foliar sprays are recommended for the first 2 years, in addition to soil applications. See Table 9–2, *Magnesium foliar sprays*, page 155.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate. It is best to apply magnesium sulfate separately or try it on a few plants first. Check manufacturer's label regarding mixing magnesium chelates[1] with pesticides.

Calcium (Ca)

Calcium deficiency has been associated with stem and bunch breakdown of Canada Muscat and Himrod grapes. If applied too close to harvest, some formulations of calcium chloride ($CaCl_2$) result in poor fruit finish.

- Use $CaCl_2$ (77% flakes) at 4 kg/1,000 L of water from early July to mid-August. Apply 3 sprays, 10–12 days apart. The more calcium applied, the better the control; but high concentrations can cause foliar burning.
- Do not apply calcium formulations containing nitrogen after the end of July or fruit quality may suffer.

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[1] Use chelates recommended for foliar sprays.

- Apply calcium in adequate water volume to wet the entire vine. Calcium sprays must contact the fruit for uptake to be effective.

For all formulations, consult label directions for concentrations to use and for compatibility with pesticides. The product used is not as important as the total amount of actual (elemental) calcium applied. For example, calcium chloride (77% flakes) contains 28% actual calcium. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of 4, or more, sprays. Calcium sprays may damage foliage and fruit if applied during low temperatures and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather.

Micronutrients for Grapes

Deficiencies of micronutrients or trace elements are not widespread in Ontario plantings. The desirable range for micronutrients is quite narrow. More damage is possible if micronutrients are applied in excess, rather than from deficiencies. For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency. Only apply the nutrient that is deficient and in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency occurs mainly on alkaline soils (pH greater than 7.0), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter, on sandy knolls, or exposed and eroded subsoils. Boron deficiency can affect growth and fruiting. There is currently no accredited soil test for boron in Ontario. Use a petiole analysis to check for deficiencies. Boron levels of 20–60 ppm are considered adequate. Where boron is deficient, soil or foliar applications of boron may improve plant tissue levels. There are several sources of boron. Check the manufacturer's recommended rates and timing of applications.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit-growing areas of Ontario. Its occurrence is closely related to weather conditions, particularly rainfall and soil moisture, as well as soil pH. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip. Leaf analysis and soil tests determine the status of manganese in the soil. Soils with OMAF manganese index values greater than 8 provide adequate manganese to the crop.

- If manganese is required, apply as a foliar spray of manganese sulphate or chelate.
- Use manganese sulphate with a spreader sticker.
- Consult manufacturer's label for complete information on rates and timing.

Soil applications of manganese are not effective.

Iron (Fe)

Iron is abundant in most soils. However, its solubility is very low. Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition becomes more severe, the whole leaf becomes pale yellow. Quite often only one side or one branch of the plant is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a petiole analysis. Generally, applying inorganic iron sources to soil is not effective in supplying iron to the crop. Correction of iron deficiency is relatively easy with iron chelates[1]. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

Zinc (Zn)

Zinc deficiency symptoms include short internodes, small narrow leaves and interveinal chlorosis with shoot and branch die back. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes". This results in the typical "rosette" and "little leaf" description for zinc deficiency. Use petiole analysis and soil tests to determine the status of zinc in the soil. Soils with an OMAF soil zinc index value greater than 8 provide adequate zinc to the crop. Where a zinc deficiency exists, check manufacturer's recommended rates and timing of applications of zinc products.

Warning: Do not concentrate nutrient sprays.

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[1] Use chelates recommended for foliar sprays.

GRAPE CALENDAR

Read the label and follow all safety precautions. Some grape varieties are sensitive to Sulphur, Thiodan, Copper, Dikar, Dikar plus Zolone, or other products. See Table 9–5, *Relative disease susceptibilities* on page 168 for specific information.

Resistance Management

To delay development of resistance to fungicides, miticides and insecticides, follow resistance management guidelines outlined in *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. In addition, take the following steps to avoid rapid development of fungicide resistance:

- Do not reduce label rates.
- Do not use Nova, Sovran or Flint as eradicants when powdery mildew is already a severe problem.
- Use at least 1,000 L/ha of water or sufficient water to provide good coverage of the fruiting zone.

Many processors require longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Some processors also have special restrictions for certain pest control products, regarding number of applications or application after a certain crop stage. Consult the contract purchaser of your grapes for more details.

Sufficient water volumes are necessary to provide complete coverage with grape fungicides, miticides and insecticides. Increased water volumes are necessary as the season progresses and canopies grow. Canopy management (hedging, leaf-pulling, shoot thinning) and proper sprayer calibration are critical to ensuring proper spray penetration during the growing season. Although water is only the carrier for pesticides, sufficient coverage and efficacy is not possible if water volumes are severely reduced. Some types of sprayers are able to provide sufficient coverage with less water than other sprayers. Consult with equipment dealers and professional crop consultants about the amount of water needed to ensure adequate coverage. Read and follow water volume requirements on all product labels.

Diseases and Insects	Materials	Amount/ha	Comments
First leaf, 1.25–5.0 cm shoot length			
Phomopsis cane and leaf spot	• [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Folpan 50 WP	see label 2.00 kg see label	Begin spraying susceptible varieties early where there has been a history of phomopsis and conditions are wet. Apply in sufficient water volume to ensure complete coverage.
3–5 leaves unfolded, 10–15 cm shoot length			
Phomopsis cane and leaf spot	• [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Folpan 50 WP	see label 2.00 kg see label	Begin spraying susceptible varieties early where there is a history of phomopsis and conditions are wet. Apply in sufficient water volume to ensure complete coverage.
Black rot	• Nova 40 W • Ferbam 76 WDG	200 g see label	
Powdery mildew	• Nova 40 W • [4]Dikar • Microscopic wettable sulphur or Kumulus 80 DF	200 g 5.50 kg see label 12.60 kg	This spray is important to protect expanding leaves and developing fruit clusters from infections. Intervals between sprays should be about 7–10 days. Under rainy conditions, spray at 7-day intervals. Do not use Nova more than 3 times/season.
Shoot length, 20–25 cm			
Phomopsis cane and leaf spot	• [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Folpan 50 WP	see label 2.00 kg see label	Begin spraying susceptible varieties early where there is a history of phomopsis and when conditions are wet. Apply in sufficient water volume to ensure complete coverage.

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[1] *Minimum period for re-entry is 4 hr.* [2] *Minimum period for re-entry is 12 hr.* [3] *Minimum period for re-entry is 24 hr.* [4] *Minimum period for re-entry is 48 hr.*
[5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.*
[8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Black rot	• Nova 40 W • Ferbam 76 WDG • Polyram DF • [8]Sovran • [7]Flint 50 WG	200 g see label see label 240 g 140 g	Sovran and Flint belong to the same chemical family (see Table 4–2. *Fungicide/bactericide groupings based on sites of action.* on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label): do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur.
Downy mildew	• [2]Ridomil Gold MZ 68 WP • Manzate 200 WP • [4]Dikar • Polyram DF • Maestro 80 DF or [5]Supra Captan 80 WDG • Folpan 50 WP • [4]Gavel 75 DF • [8]Sovran	2.50 kg 6.75 kg 5.50 kg see label 2.00 kg see label see label 2.25 kg 300 g	If bloom is delayed or wet weather is expected, repeat this application. Ridomil Gold MZ may be used only once/season and only prior to bloom. Apply no more than 2 consecutive sprays of Sovran and no more than 4 Sovran sprays/season. If applying 2 consecutive sprays of Sovran, use a 14 day interval. If alternating Sovran with another fungicide, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.
Powdery mildew	• Nova 40 W • [4]Dikar • Microscopic wettable sulphur or Kumulus 80 DF • [8]Sovran • [1]Lance WDG • [7]Flint 50 WG	200 g 5.50 kg see label 12.6 kg 300 g 315 g 140 g	This spray is important to protect expanding leaves and developing fruit clusters from infections. Intervals between sprays need to be no more than 14 days. Under rainy conditions, intervals may need to be shortened. Sovran and Flint belong to the same chemical family (see Table 4–2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label): do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur. Do not use Nova more than 3 times/season. Do not use Lance more than 2 times/season.
Immediate prebloom (flower cluster with floret separation)			
Black rot	• Nova 40 W • Ferbam 76 WDG • [8]Sovran • Polyram DF • [7]Flint 50 WG	200 g see label 240 g see label 140 g	This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to black rot from bloom to pea-sized berries stage. Sovran and Flint belong to the same chemical family (see Table 4–2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14 day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label): do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Grape berry moth (1st generation)	• [9]Guthion Solupak or [9]Guthion 240 SC or [9]Sniper 50 W • Isomate GBM • 3M Sprayable Pheromone • Isomate GBM Plus • Imidan 50 WP • Diazinon 50 W • Sevin XLR Plus • Cymbush 250 EC • Pounce	see label see label see label 1,000 dispensers 75 mL 500 dispensers 1.90 kg 3.375 kg 5.25 L 240 mL 360 mL	Where there is a history of early season grape berry moth injury, apply an insecticide for 1st generation. Apply in high water volumes to ensure complete coverage. **Mating Disruption:** Vineyard block treated must be larger than 2 ha. i) *Isomate GBM*: Apply Isomate GBM products in late April or early May prior to flight and mating of grape berry moth (GBM) adults. Isomate GBM lasts for approximately 60 days while Isomate GBM Plus lasts for approximately 150 days. ii) *3M Sprayable Pheromone*: Apply the 1st application of 3M Sprayable Pheromone for GBM control in late April or early May, prior to 1st capture of moths in pheromone-baited traps. Delayed application results in increased mating and reduced control. The capture of moths in traps should remain at or near zero after application. Reapply at 14–21 day intervals during adult flight periods to ensure continued mating disruption of GBM. Isomate GBM and 3M Sprayable Pheromone are specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is adequately controlled and to determine if special sprays are necessary for other sporadic pests such as leafhoppers. For more information see *Mating Disruption (MD) Technology for Management of Grape Berry Moth* on page 165 and OMAF Factsheet *Mating Disruption for Management of Insect Pests*, Order No. 03-079.
Downy mildew	• [2]Ridomil Gold MZ 68WP • Manzate 200 WP • [3]Dikar • Polyram DF • [5]Maestro 80 DF or [5]Supra Captan 80 WDG • Folpan 50 WP • [4]Gavel 75 DF • [8]Sovran	2.50 kg 6.75 kg 5.50 kg see label 2.00 kg see label see label 2.25 kg 300 g	If bloom is delayed or wet weather is expected, repeat the application. This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to downy mildew during bloom to pea-sized berries. Apply no more than 2 consecutive sprays of Sovran and no more than 4 Sovran sprays/season. If applying 2 consecutive sprays of Sovran, use a 14 day interval. If alternating Sovran with another fungicide, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Ridomil Gold MZ may be used only once/season and only prior to bloom.

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[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	• Nova 40 W • [4]Dikar • Microscopic wettable sulphur or Kumulus 80 DF • [8]Sovran • [1]Lance WDG • [7]Flint 50 WG	200 g 5.50 kg see label 12.6 kg 300 g 315 g 140 g	This spray is important to protect expanding leaves and developing fruit clusters from infections. Fruit clusters are highly susceptible to powdery mildew from bloom to pea-sized berries. Intervals between sprays over the bloom period should ideally be 7 days. Under rainy conditions, intervals may need to be shortened. Sovran and Flint belong to the same chemical family (see Table 4–2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14 day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur. Do not use Lance more than 2 times/season. Do not use Nova more than 3 times/season.
DO NOT APPLY INSECTICIDES WHILE GRAPES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.			
Immediate post-bloom to early fruit set stage			
Leafhoppers	• [9]Guthion Solupak or [9]Guthion 240 SC or [9]Sniper 50 W • Sevin XLR Plus • Diazinon 50 W • Cymbush 250 EC • Pounce • [2]Assail 70 WP	see label see label see label 5.25 L 3.375 kg 240 mL 175 mL 80 g	Grape leafhopper (GLH), potato leafhopper (PLH) and three banded leafhopper (TBLH) are the 3 main species of leafhoppers that feed on grapes. GLH causes pale white stippling along the veins. TBLH damage is similar to GLH. In some vineyards, Guthion no longer gives control of GLH. PLH feeding causes the leaves to yellow along the margins. Leaves cup upwards and later develop marginal necrosis. All products listed provide control of PLH.
Grape phylloxera (leaf form)	• Thiodan 50 WP or Endosulfan 50 W	3.00 kg 2.50 kg	Only French hybrid and vinifera varieties are susceptible to this pest.
Downy mildew	• Manzate 200 WP • [4]Dikar • Polyram DF • [5]Maestro 80 DF or [5]Supra Captan 80 WDG • Folpan 50 WP • [4]Gavel 75 DF • [8]Sovran	6.75 kg 5.50 kg see label 2.00 kg see label see label 2.25 kg 300 g	Spray all varieties for downy mildew at this time. Apply no more than 2 consecutive sprays of Sovran and no more than 4 Sovran sprays/season. If applying 2 consecutive sprays of Sovran, use a 14 day interval. If alternating Sovran with another fungicide, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops.
Black rot	• Nova 40 W • Folpan 50 WP • [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Polyram DF • [8]Sovran • [7]Flint 50 WG	200 g see label see label 2.00 kg see label 240 g 140 g	Sovran and Flint belong to the same chemical family (see Table 4–2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14 day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	• Nova 40 W • Microscopic wettable sulphur or Kumulus 80 DF • [4]Dikar • [8]Sovran • [1]Lance WDG • [7]Flint 50 WG	200 g see label 12.6 kg 5.50 kg 300 g 315 g 140 g	Fruit clusters are highly susceptible to powdery mildew from bloom to pea sized-berries stage. Young developing fruit and leaves are very susceptible at this stage. It is important to maintain protectant coverage. Intervals between sprays should be 7 days. Under rainy conditions intervals may need to be shortened. Do not use Nova more than 3 times/season. Sovran and Flint belong to the same chemical family (see Table 4–2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur. Do not use Lance more than 2 times/season.
Botrytis bunch rot	See comments for botrytis bunch rot control under **Berry touch to cluster closure**.		
Berries pea-sized			
Grape berry moth (2nd generation)	• [9]Guthion Solupak or [9]Guthion 240 SC or [9]Sniper 50 W • Isomate GBM • 3M Sprayable Pheromone • Imidan 50 WP • Diazinon 50 W • Sevin XLR Plus • Cymbush 250 EC • Pounce	see label see label see label 1,000 dispensers 75 mL 3.10 kg 3.375 kg 5.25 L 240 mL 360 mL	Where berry moth is a regular problem, apply one of these materials in high water volumes to ensure complete coverage. **Mating Disruption**: Vineyard block must be larger than 2 ha for treatment. i) *Isomate GBM*: Apply 2nd application of Isomate GBM dispensers 60 days after 1st application (about late June or early July) but before significant 2nd flight of grape berry moth (GBM). ii) *3M Sprayable Pheromone*: Apply 3M Sprayable Pheromone for grape berry moth (GBM) control before flight of second generation begins. Delayed application will result in increased mating and reduced control. Moth trap catches should remain at or near zero after application. Reapply at 14–21 day intervals during adult flight periods to ensure continued disruption of GBM. Isomate GBM and 3M Sprayable Pheromone are specific for GBM and will not control other pests. Insect monitoring and sampling must be carried out throughout the season to ensure that GBM is being adequately controlled and to time special sprays for other sporadic pests such as leafhoppers. For more information see *Mating Disruption (MD) Technology for Management of Grape Berry Moth* on page 165 and OMAF Factsheet *Mating Disruption for Management of Insect Pests*, Order No. 03-079.
Phylloxera (leaf form)	Repeat as in **End of late flowering to early fruit set stage**.		
Powdery mildew	• Nova 40 W • [4]Dikar • Microscopic wettable sulphur or Kumulus 80 DF • [1]Lance WDG • [7]Flint 50 WG • [8]Sovran	200 g 5.50 kg see label 12.6 kg 315 g 140 g 300 g	Sovran and Flint belong to the same chemical family (see Table 4–2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14 day interval. If alternating with a fungicide from a different family, use a 7–10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Do not use Lance more than 2 times/season. Do not apply Flint to Concord grapes or crop injury may occur.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Downy mildew	• [4]Dikar • Folpan 50 WP • [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Polyram DF • [4]Gavel 75 DF	5.50 kg see label see label 2.00 kg see label 2.25 kg	
Black rot	• Nova 40 W • Ferbam 76 WDG • Folpan 50 WP • [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Polyram DF • [7]Flint 50 WG • [8]Sovran	200 g see label see label see label 2.00 kg see label 140 g 240 g	For effective control, apply in high water volumes to ensure coverage. Sovran and Flint belong to the same chemical family (see Table 4-2 on page 47). Apply no more than 2 consecutive sprays of either product and no more than 4 sprays of either product/season. If applying 2 consecutive sprays of either product, use a 14-day interval. If alternating with a fungicide from a different family, use a 7-10 day interval. Sovran is phytotoxic to some varieties of cherries (see label); do not let product drift onto sensitive crops. Do not apply Flint to Concord grapes or crop injury may occur.
Berry touch to cluster closure			
Powdery mildew	• Nova 40 W • Microscopic wettable sulphur or Kumulus DF • [4]Dikar • [1]Lance WDG	200 g see label 12.6 kg 5.50 kg 315 g	Do not use Lance more than 2 times/season.
Downy mildew	• [4]Dikar • Folpan 50 WP • [5]Supra Captan 80 WDG or [5]Maestro 80 DF • Polyram DF • [4]Gavel 75 DF	5.50 kg see label see label 2.00 kg see label 2.25 kg	
Botrytis bunch rot	• [2]Rovral • [4]Vangard 75 WG • [1]Elevate 50 WDG	1.50 kg 750 g 1.12 kg	Direct this spray at the fruiting zone. Many of the vinifera and vinifera hybrid varieties with tight clusters are susceptible to botrytis bunch rot e.g., Gamay Noir, Pinot Noir, Pinot Gris, Riesling, Chardonnay, Chancellor and Seyval Blanc. These susceptible varieties may require more than 1 application during the bunch closure period. For Elevate use Agral 90 at 200 mL/1,000 L of water (0.02% v/v) with the product in the tank. Do not apply Elevate if rainfall is expected within 6 hours after application.
Mites	• [5]Pyramite • Kelthane 50 W	300 g 2.00 kg	A miticide may be required if significant bronzing of mid shoot leaves occurs as a result of mite infestation. Stressed vines will show injury earlier than healthy vines. Monitor 7-10 days after application to evaluate mite control. Pyramite is most effective against active nymphal stages, not adults. Use either miticide only once/season and alternate. One miticide/year and alternating products is an effective resistance management strategy.

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[5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.*
[8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*
FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Beginning of ripening (veraison period)			
Grape berry moth	• 3M Sprayable Pheromone	75 mL	Applications for control of 2nd and 3rd generation should be continuous over the period of adult flight. Delayed application will result in increased mating and reduced control. Moth trap catches should remain at or near zero after application. Reapply at 14–21 day intervals during adult flight periods to ensure continued disruption of GBM. For more information see *Mating Disruption (MD) Technology for Management of Grape Berry Moth* on page 165 and refer to comments for GBM at *Berries pea-sized* on page 162.
Grape berry moth (about Aug. 20)	Use one of the materials listed under **Berries pea-sized**.		Check the interval to harvest. A spray may be needed on late varieties to control the brood which emerges in late Aug. Border sprays of conventional insecticides may be very effective. For 3M Sprayable Pheromone, spray the entire block.
Powdery mildew	Use one of the materials listed under **Berry touch to cluster closure**. Check for interval to harvest.		Vinifera and French hybrid varieties are more susceptible and may require extra sprays.
Downy mildew	Use one of the materials listed under **Berry touch to cluster closure**.		
Botrytis bunch rot	• [4]Vangard 75 WG • [1]Elevate 50 WDG • [2]Rovral	750 g 1.12 kg 1.50 kg	When late summer or fall weather conditions are wet and humid, protection against botrytis is necessary during the ripening or veraison period. This is especially important for vineyards designated for late harvest or ice wine. For further information on product choice and use, see comments under **Berry touch to berry closure.**
Slugs and snails	• Sluggo	25 kg	Apply higher rate of 50 kg/ha if population is very high. Apply when infestation begins. Reapply as the bait is consumed, or at least every 2 weeks if slugs and snails continue to be a problem.
Postharvest			
Hardening-off vines	• Copper sulphate plus Lime • Copper 53 WP plus Lime	4 kg/1,000 L 6 kg/1,000 L 3 kg/1,000 L 6 kg/1,000 L	Postharvest applications of copper may assist in maturing current season growth, which often helps improve the winter hardiness of canes. 2 applications or more may be necessary in high vigour and/or young plantings. Use sufficient water volume to ensure complete coverage of the vine. Some premature defoliation may be observed, but is not likely to affect vine vigour. See *Use of Copper Products on Fruit Crops* on page 54 for information on how to mix copper sprays.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 9–4. Days to harvest intervals for products used on grapes

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the number of days between the last spray and first harvest.

Product Name	Preharvest interval
Assail 70 WP	7
Supra Captan 80 WDG	7
Copper 53W	1*
Cymbush 250 EC	7
Diazinon 50W	16
Dikar	30
Elevate 50 WDG	7
Endosulfan 50W	30
Ferbam 76 WDG	7
Flint 50 WG	14
Folpan 50 WP	1
Gavel 75 DF	66
Guthion 240 SC	28
Guthion Solupak	28
Imidan 50 WP	7
Kelthane 50 W	7
Kumulus DF	21**
Lance	14
Maestro 80 DF	7
Manzate 200 WP	30
Nova 40W	14
Polyram DF	45
Pounce	21
Pyramite	25
Ridomil Gold MZ	PB
Rovral	7
Sevin XLR Plus	5
Sluggo	0
Sniper 50W	28
Sovran	14
Sulphur	21**
Thiodan 50 WP	30
Vangard 75 WG	7

PB: prebloom
* check with processor for wine grapes
** 21 days for wine grapes. 1 day for table grapes

NOTES ON GRAPE INSECTS

Mating Disruption (MD) Technology for Management of Grape Berry Moth

See OMAF Factsheet *Mating Disruption for Management of Insect Pests*, Order No. 03-079 for more information.

Many adult insects, usually females, emit volatile chemicals known as sex pheromones to attract members of the opposite sex. When a female moth secretes these chemicals, males respond to the pheromone trail or "plume", using it to pinpoint her location. Synthetically produced sex pheromones have been used for decades to monitor insect activity patterns.

Mating disruption (MD) technology uses these same chemicals to confuse males and limit their ability to locate pheromone emitting ("calling") females. Releasing sufficiently large quantities of synthetic sex pheromone into the crop environment interferes with mate location by masking the trail or pheromone plume emitted by the female moth. The probability of the male finding the female is reduced, along with the likelihood of successful mating. As a result, mating is either delayed or prevented. The subsequent population is reduced and fewer larvae are present to cause crop damage.

Pheromone products are available for the management of grape berry moth (GBM).

- To use Isomate GBM or Isomate GBM Plus place pheromone dispensers uniformly through the vineyard.
- If using 3M Sprayable Pheromone apply with conventional spray equipment.

The advantages of MD technology include:

- **Pest specificity**. Since synthetic pheromones are not harmful to non-target organisms, populations of beneficial mites and insects may increase.
- **Low toxicity**. Pheromones are non-toxic and present no hazard to farm workers.
- **Resistance management**. MD reduces pressure for development of insect resistance to pesticides. MD is easily incorporated into IPM programs.
- **Efficacy**. When applied as directed, pest control is comparable or superior to that obtained using conventional products.

- **Timing**. Pheromone dispensers are applied, by hand, 1–2 times/season, depending upon the formulation and dispenser. Their effectiveness does not depend on weather conditions. Sprayable formulations can be applied using conventional equipment prior to moth flight of each generation. Apply both products as directed on their respective labels.

Insect monitoring, sampling and damage assessments must be conducted throughout the season to ensure that GBM are adequately controlled and to determine if special sprays are necessary for other sporadic pests such as leafhoppers, mites, and spring feeding caterpillars. **Regular monitoring is critical to the successful implementation of any IPM program.**

Choosing a site for mating disruption

Vineyards should be at least 2 ha in size. Mating disruption works best in vineyards with low GBM populations. Avoid vineyards located next to vineyards with known high populations of grape berry moth.

Applying pheromone

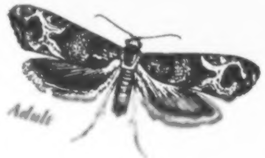
It is critical that synthetic pheromones be applied prior to, or at the onset of, moth emergence. Delayed application results in increased mating and reduced control.

- Use hand applied dispensers such as Isomate GBM in late April or early May prior to 1st spring flight of moths. Reapply according to the manufacturer's recommended number of applications per season.
- Attach dispensers securely to the upper training wire close to the vines. Dispensers must be applied throughout the vineyard in sufficient numbers to achieve an adequate release of synthetic pheromone throughout the field.
- Wear gloves when applying pheromone dispensers to avoid cross-contamination with other pheromone products.
- If required, make the 2nd application of pheromone approximately 60 days later (i.e. July 15–Aug. 1), or as indicated on the product label.

Sprayable formulations must also be applied prior to significant moth activity.

- Apply sprayable pheromone following 1st moth catch, as indicated by pheromone monitoring traps. The capture of moths in traps should remain near zero after application.
- To ensure continued mating disruption of GBM, reapply at 14–21 day intervals or as indicated by the product label.
- Reapply sprayable formulations for each new generation.

Monitoring for grape berry moth



- Use 5 pheromone traps for vineyards up to 5 ha in size.
- Place traps along a line that transects the vineyard or at the 4 corners of the vineyard. In addition, place at least 1 extra trap along the windward edge of the vineyard. Where vineyards are located adjacent to wooded areas, place traps within the border area, at least 40 m apart.
- Bait the traps with commercial lures.
- Inspect traps twice weekly on the same days each week and record the number of moths. Replace lures every 4 weeks. Captures of moths in pheromone traps should be very low to zero in vineyards using MD.
- If more than 2 moths per 5 traps in total are caught during a flight period of a generation, apply supplemental insecticides, using the appropriate timing.
- Inspect vineyards weekly for signs of fruit infestation. Make the fruit inspections along a transect. In addition, carefully inspect border areas, especially those on the windward side, for signs of fruit infestation.
- If more than 5% of the grape clusters are infested with grape berry moth larvae, apply supplemental insecticides using the appropriate timing.

Mating disruption technology prevents mating of grape berry moth adults. However, if mated female moths of this species are present in adjacent areas, migration of these moths into a pheromone treated vineyard reduces the level of control achieved. Sources of mated females include unsprayed vineyards or wild grapevines within 100 m of the treated vineyard. Migration of mated females can be prevented by:

- treating entire blocks, not just sections of large conventionally treated fields, with pheromones
- treating sources of infestation with pheromone dispensers before moth flight(s)
- treating infestation source(s) with an effective insecticide and
- treating edges of vineyard with timely insecticide applications.

NOTES ON GRAPE DISEASES

Use of Nova 40 W on Grapes

Nova is a member of the Demethylation Inhibitors (DMIs), a group of fungicides loosely known as sterol inhibitors. It must be used differently from the "protectant" fungicides such as captan or mancozeb.

DMI fungicides are systemic and must be absorbed by the leaf and fruit tissue to be effective. Nova is absorbed within 1 hour of application, and effectiveness is not reduced if rain occurs more than 1 hour after application.

Nova does not redistribute well after application. Therefore, uniform spray coverage is essential for good disease control.

Nova gives good control of powdery mildew and black rot, but not downy mildew or botrytis bunch rot.

Crown Gall Disease of Grapevine

Crown gall, caused by the bacterium *Agrobacterium vitis*, is a serious problem where grapes are grown in climatic conditions that favour freeze injury. Severely diseased vines usually exhibit significant reductions in yield and vigour, predisposing them to winter kill.

Cultural practices for crown gall control

Use best available nursery stock. Latently infected nursery stock is the major source of infection. Grafting wood from warm climates often harbours the pathogen that induces crown gall symptoms in vines grown in cooler climates. Hot water treatment of nursery stock prior to grafting significantly reduces levels of crown gall infection. At present, there is no commercially-available crown gall-free certified nursery stock available in Canada, although several nurseries are evaluating heat treatment.

Use the following management practices to reduce injury, since crown gall is closely correlated with injury.

- For new plantings, select sites with good soil and air drainage not prone to freeze injury.
- Select hardy, cold-tolerant cultivars where possible. Do not plant cold-sensitive varieties in marginal areas with poor soil drainage and exposure to cold temperatures.
- Hill trunks in the fall with soil to protect the crown from cold temperatures. This ensures new shoots for trunk renewal or replacement the following season.
- Avoid injuring vines during cultivation, since the soil inhabiting pathogen enters through wounds, particularly in spring and early summer.
- Train multiple trunks of differing ages to allow renewals to replace trunks killed by cold temperatures or by crown gall. This does not eliminate the pathogen, but it helps ensure a crop, allowing management of the disease at a tolerable level.
- Apply nitrogen in early spring. Avoid excessive rates. Vines that grow late in the season do not adequately harden-off and have a higher water content going into winter. These vines are more prone to winter injury and crown gall infection. Excessive N can cause rapid growth in the spring. This can cause bark splits, which provide entry points for infection.
- When removing diseased vines from a vineyard, remove as much of the root system as possible before replanting. The significance of soil inoculum in replanted vineyards is poorly understood. Soil infection of newly planted vines can occur if sufficient amounts of the pathogen are present.

Fallowing the land or planting other crops for several years reduces *A. vitis* in the soil. Infected roots left in the soil after vine removal are a reservoir of inoculum. These populations likely lead to greater persistence of the pathogen in the field. By using clean planting stock and managing soil populations of *A. vitis* you may provide effective control of crown gall because:

- *A. vitis* has not been detected in soils where grapevines have not been grown
- levels of soilborne *A. vitis* decline in the absence of grapevines
- low levels of *A. vitis* fail to increase around grapevine roots.

Topical chemical treatments are ineffective because the pathogen is systemic in the grapevine and new galls will develop around or beyond the treatment site. Soil fumigation is generally ineffective, particularly in heavier soils, but also in light-textured soils where roots often extend deeper than the fumigant application. The pathogen can remain viable in the soil as long as infected living grape root material is present.

Researchers hope to develope a biological control agent for "immunizing" vines against crown gall disease. This would provide protection for clean nursery stock planted into sites with a history of crown gall disease. However, at present, no biological agents are commercially available to protect nursery stock against this disease.

Relative Disease Susceptibilities

Table 9–5, *Relative Disease Susceptibilities*, provides a relative rating of grape variety susceptibility based on observations in Ontario and northeast United States under average conditions. Under adverse weather conditions, for example, extended cool weather, any given variety may be more seriously affected.

TABLE 9–5. Relative disease susceptibilities

— = relative susceptibility is unknown
+ = slight susceptibility
++ = moderate susceptibility
+++ = highly susceptible

1 = Sulphur sensitive
2 = Dikar + Zolone combination may be phytotoxic
3 = Dikar sensitive
4 = Thiodan sensitive
5 = Copper sensitive

Cultivar	Type[a]	Eutypa dead arm	Phomopsis cane blight	Black rot[b]	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity[c]
Vinifera Wine								
Auxerrois	V	—	++	—	+	+++	+++	
Cabernet Franc	V	—	++	+++	++	+++	+	
Cab. Sauvignon	V	++	++	+++	++	+++	+	
Chardonnay	V	+	++	+++	++	+++	++	3
Gamay	V	+	+	+	++	+++	++	
Gewurztraminer	V	++	—	+++	++	+++	+++	
Kerner	V	—	—	—	+++	++	+	
Merlot	V	—	+	++	++	+++	+	5
Pinot Blanc	V	—	—	+++	++	+++	+++	
Pinot Gris	V	—	—	+++	++	+++	+++	
Pinot Noir	V	—	—	+++	++	+++	+++	
Riesling	V	+	+	+++	++	+++	+++	
Sauvignon Blanc	V	—	—	++	++	++	+++	5
Scheurebe	V	—	—	—	+	+++	+	
Zweigeltrebe	V	—	++	+++	++	+++	+	
Hybrid Wine								
Baco Noir	FH	—	++	+	+	++	+	4
Chambourcin	FH	—	+	++	++	++	+	1,4
Chancellor	FH	—	+	+	+++	+++	++	5
Chelois	FH	+++	++	++	+	+++	++	3
Couderc Muscat	FH	—	—	++	—	+++	+	
De Chaunac	FH	+	+++	+	+	++	+	1
Foch	FH	++	++	+	+	++	+	1,2,3
J.S.23-416	FH	—	+	—	—	++	—	
Rosette	FH	—	++	++	+++	++	+	
Seyval Blanc	FH	—	++	++	++	+++	+++	
S.V. 23-512	FH	—	+	—	—	++	—	
Vidal 256	FH	—	+	+	++	++	+	5
Ventura	AH	++	++	++	++	++	—	
Villard Noir	FH	—	+	—	—	++	+	3, 4

TABLE 9–5. Relative disease susceptibilities (cont'd)

Cultivar	Type[a]	Eutypa dead arm	Phomopsis cane blight	Black rot[b]	Downy mildew	Powdery mildew	Botrytis bunch rot	Phytotoxic chemical sensitivity[c]
Juice & Table								
Agawam	L	+	++	+++	+++	++	—	
Canadice	AH	—	—	+++	+	+	++	
Concord	L	+	++	++	++	++	+	1,4,5
Elvira	L	+++	+++	++	+	++	++	5
Festivee	AH	—	—	—	+	+++	++	
Fredonia	L	+	++	++	+++	++	+	
Himrod	AH	—	+	++	+	++	—	
N.Y. Muscat	L	+	—	+	+	++	+	
Niagara	L	++	++	+++	+++	++	+	5
Sov. Coronation	L	—	+	—		+	—	
Van Buren	L	+	—	—	+++	++	—	1
Vanessa	AH	—	+	+++	++	++	+	

[a] Species type

[b] Black rot is more serious adjacent to bush or similar areas with poor air drainage.

[c] These notes are based on grower experience and could vary under stress conditions.

L = labrusca
AH =American hybrid
FH =French hybrid
V = Vinifera (vinifera varieties not included in this chart are considered susceptible to powdery mildew)

TABLE 9–6. Effect of fungicides on grape diseases

Use fungicides only for diseases listed on the product label.

Fungicide	Phomopsis cane and leaf spot	Black rot	Downy mildew	Powdery mildew	Botrytis bunch rot
Supra Captan 80 WDG	+++	++	+++	0	+
Copper-Lime	+	++	++	++	0
Dikar	+	+++	+++	+++	0
Elevate 50 WDG	0	0	0	0	+++
Ferbam 76 WDG	+	+++	++	0	0
Flint 50 WG	+	+++	++	+++	+
Folpan 50 WP	+++	++	++	+	+
Gavel 75DF	?	?	+++	0	?
Kumulus DF	0	0	0	+++	0
Lance WDG	?	++	0	+++	++
Manzate 200 WP	+	+++	+++	0	0
Nova 40 W	0	+++	0	+++	0
Polyram DF	?	+++	+++	0	0
Ridomil Gold MZ	?	?	+++	?	?
Rovral	0	0	0	+	++
Sovran	+	+++	++	+++	+
Sulphur	0	0	0	+++	0
Vangard 75 WG	0	0	0	0	+++

0 = ineffective   + = slightly effective   ++ = moderately effective   +++ = very effective

10. Tender Fruit (Stone Fruit and Pears)

TENDER FRUIT NUTRITION

It is important to prepare and test soil before planting trees. To ensure long-term productivity of these perennial crops, till the soil and add organic matter, well in advance of planting. For information on building and maintaining soil organic matter see *Managing Organic Nutrient Additions* on page 30 and *Manure for Orchards* below.

Prior to planting, ensure adequate nutrient levels and pH. Test the soil, apply fertilizer and lime if necessary. Refer to *Fertilizer for non-bearing tender fruit* on page 172. Preplant applications of phosphorus, potassium and lime are most effective.

Manure for Orchards

A spring application of manure can be beneficial in providing nutrients and organic matter to established orchards. However, see *Food safety concerns with manure application and timing* on page 33. Manure benefits cultivated orchards more than those in permanent sod because manure is easily worked into the soil, making it available to tree roots. Manure can also be applied in the fall to provide nutrients and organic matter prior to spring planting.

- Broadcast manure at no more than 7 tonnes/ha of poultry manure (20 m^3 liquid), 40 t/ha of cattle manure (100 m^3 liquid) or 35 t/ha hog manure (65 m^3 liquid).
- As the nutrient content of manure is extremely variable, analyze it before applying.
- When using manure, reduce the rate of fertilizer. Table 3–5, *Average amounts of available nutrients for different types of manure,* on page 31 shows the average composition of some manures and suggested reduction in fertilizer when using manure.
- For more information about food safety and environmental affects when applying manure, see *Environmental concerns with manure* on page 32 and *Food safety concerns with manure application and timing* on page 33.
- Do not place manure around newly planted trees because of potential winter injury problems.

Nitrogen in manure becomes available over a long time. Perennial crops that have manure applied continue to be supplied with nitrogen during the year. This can be a disadvantage, resulting in:

- poor fruit colour
- excessive terminal growth
- delayed hardening of the woody tissue
- increased susceptibility to winter injury.

pH Requirements

The pH of a soil is a measure of its acidity. If the pH is not at an acceptable level, nutrient uptake and crop performance can be hindered. Take a soil sample to determine its pH. For information on soil sampling, consult *Soil Testing* on page 25.

- Always take a soil sample before establishing a new planting. The preferred pH before establishing a new orchard is 6.5 on sandy soils and 6.0 on clay soils. If lime is required, incorporate it during soil preparation.
- In established orchards, sample soil in the tree row every 3 years to ensure the pH is satisfactory. Lime is not needed if the pH in established orchards is above 5.6.
- Apply lime to established orchards when the pH on clay loam soils drops below 5.1, and on sandy soils below 5.6.
- Apply lime to the sod cover in the fall or before spring cultivation. The results will not be immediately evident because lime moves slowly into soil. The lime raises soil pH and also supplies calcium.
- Use dolomitic lime (high in magnesium) on soils low in magnesium.

TABLE 10–1. Nutrient level range (% dry weight) of mid-shoot leaves (taken last 2 weeks of July from mature trees)

	Nitrogen*		Potassium		Magnesium
Leaf Analysis	Low if below	High if above	Low if below	High if above	Low if below
PEACH	3.4	4.1	2.3	3.5	0.35
PEAR	2.0	2.6	1.2	2.0	0.25
CHERRY					
Montmorency	2.2	3.0	1.3	2.5	0.35

* Leaf nitrogen in non-bearing trees should be 0.2% higher.

Application rates vary with soil type and initial pH. The buffer pH determines the rate of lime to apply. For information on lime, consult *Soil Acidity and Liming* on page 28. See Appendix B, page 232, for accredited soil testing laboratories.

Leaf Analysis

In established plantings leaf analysis is the best method of determining nutrient needs. The nutrient levels in these plant tissues most accurately reflect the uptake of nutrients by the crop. Soil analysis is used in conjunction with leaf analysis to determine the nutrient status of the soil and to monitor soil acidity. A combination of both analyses best evaluates fertilizer and lime needs. For more information on these tests see *Plant Analysis* on page 26.

Nutrient uptake is affected by many orchard conditions. Consequently, each year nutrient levels vary slightly depending on the season. For optimum growth and fruit quality, adequate levels of all nutrients must be present in the leaves and their relative amounts balanced.

Even with optimum levels of nitrogen and potassium, poor growth can be attributed to low levels of magnesium, boron, zinc or other micronutrients. These will be reflected in the leaf analysis. Further information is available in OMAF Factsheet *Leaf Analyses for Fruit Crop Nutrition*, Order No. 91–012.

For leaf analysis to be most effective, sample the same trees each year and make adjustments to the fertilizer program on the basis of this leaf analysis. For nutrient ranges of pears, peaches and tart cherries leaf analysis, consult Table 10–1, *Nutrient level range of mid-shoot leaves.*

Fertilizer requirements are adjusted to the system of soil management, tree age, rootstock, soil type and previous fertilizer applications. Growth, fruit size, colour and storage quality must also be considered in determining the fertilizer required.

TABLE 10–2. Phosphorus and potassium soil requirements before planting tender fruit trees

Soil phosphorus		Soil potassium	
New plantings of peaches, pears, plums, cherries*		News plantings of peaches, pears, plums, cherries*	
Soil test (ppm P)	Phosphate (P_2O_5) req'd kg/ha	Soil test (ppm K)	Potash (K_2O) req'd kg/ha
0–3	80 L	0–15	180 L
4–5	60 L	16–30	170 L
6–7	50 L	31–45	160 L
8–9	40 M	46–60	140 L
10–12	20 M	61–80	110 L
13–15	0 H	81–100	70 M
16–20	0 H	101–120	40 M
21–25	0 VH	121–150	20 M
26–30	0 VH	151–180	0 H
31–40	0 VH	181–210	0 H
41–50	0 VH	211–250	0 VH
51–60	0 VH	250 +	0 E
61–80	0 E		
80 +	0 E		

* For established fruit trees, plant analysis is used to estimate requirements of N, P and K.

Fertilizer for Tender Fruit

Fertilizer for non-bearing tender fruit

Prior to planting is the only time elements such as phosphorus, boron and lime can be effectively worked into the soil. Adequate nutrient levels in the topsoil for orchard establishment are 12–20 ppm phosphorus, 120–150 ppm potassium, 100–250 ppm magnesium and 1,000–5,000 ppm calcium. Table 10–2, *Phosphorus and potassium soil requirements before planting tender fruit trees* provides information on fertilizer rates prior to planting.

If the soil has been prepared properly, including deep cultivation and adding organic matter, there should be an adequate supply of other nutrients to sustain the tree in the juvenile years. On coarse-textured, infertile soils, the using a starter solution at planting time (e.g., 10-52-10 or 20-20-20) may give the trees a needed boost.

- High nitrogen levels can result in excessive growth and incomplete tree hardening. Use cover crops to check late season growth in cultivated orchards, especially in new plantings. Cover crops such as Italian ryegrass, sown about July 1, take up much of the available nitrogen in the soil and limit tree growth.
- On young trees, broadcast the fertilizer under the spread of the branches at least 15 cm from the trunk, since injury can occur if placed too close.

Fertilizer for bearing tender fruit trees

Most bearing orchards require annual applications of both nitrogen and potassium fertilizer. These 2 elements significantly affect growth and productivity.

Nitrogen (N)

Nitrogen is necessary for many tree functions including growth, fruit bud formation, fruit set and fruit size. Cultivars differ in nitrogen requirements. A cultivar grown for processing could receive more nitrogen than one for the fresh market. In situations where fruit tends to be small more nitrogen may be needed. Rootstocks, spacing and pruning also affect application rates. Tree growth, foliage colour, fruit quality, including colour and storability, nutrient balance in leaves and soil, are also important considerations. Because of the complexity of nitrogen interactions with quality and production, the best guide for nitrogen rates is leaf analysis.

For pear, peach, plum, and cherry orchards where leaf analysis is not available, the following rates are considered normal.

- For each year of tree's age, apply between 30–40 g of N. Thus, a 5-year-old tree in sod culture requires 150–200 g of N. See Table 10–4, *Actual nitrogen rates per tree in sod culture,* on page 174. The rate for cultivated orchards can be cut in half as competition for nutrients is greatly reduced. Trees on dwarfing rootstock generally require more nitrogen per hectare (not per tree) than trees on more vigorous stocks. When the tree canopy has covered the space available, nitrogen fertilizer requirements level out and do not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.
- There are several forms of nitrogen available. Do not apply urea (46-0-0) to sod orchards since some nitrogen is lost by volatilization.
- For all tree fruits do not exceed the maximum rates of 200 kg actual N/ha per year, even in cases of severe deficiency. Late or excessive applications of nitrogen result in poor fruit colour and quality. Available nitrogen late in the season also encourages the tree to grow instead of harden off, potentially leading to winter injury
- In cultivated orchards, use cover crops to help lower the nitrogen level in the latter part of the season. Cover crops such as Italian ryegrass, sown about July 1, will take up much of the available nitrogen in the soil, limiting tree growth.
- In orchards with herbicide-treated strips under trees, allow some weed growth late in the season. Weeds take up extra nitrogen, which helps to harden off trees and improve fruit quality.
- If pruning is to be severe, reduce nitrogen rates or eliminate it for a year.
- During dry springs, irrigate to move the fertilizer into the rooting zone of the soil just before first bloom or immediately after petal fall.
- For fire blight sensitive pear cultivars, use less than the maximum rate of N suggested.

TABLE 10–3. Magnesium foliar sprays

Timing	Product	Rate	Notes
3 sprays spaced 2 weeks apart beginning at calyx	Magnesium sulfate (Epsom salts)	20 kg/1,000 L water	Wet tree to point of runoff. Do not concentrate beyond 40 kg/1,000 L water.
	Liquid formulations including chelates*	Consult product label	May be compatible with some pesticides. Consult product label.

* Use chelates recommended for foliar sprays.

Nitrogen placement and timing

- Apply nitrogen fertilizer in early April.
- In cultivated orchards broadcast nitrogen under the tree canopy.
- In sod orchards place the nitrogen in a band under the drip line or in the herbicide strip.
- If there is evidence of fruit bud damage due to severe winter temperatures, it may be necessary to split nitrogen applications. Apply the first application in mid April and the second, if necessary, after bloom in late May.

Foliar application of nitrogen

When weather or crop conditions create a need for additional nitrogen at a critical time, foliar applications of urea (46% nitrogen) have been successfully used on apples. Late applications adversely affect fruit quality and winter survival of the tree.

- Excessive spring rains leach spring-applied nitrogen. Apply additional fertilizer or foliar sprays after bloom.
- Do not rely on foliar sprays to completely substitute for soil applications if nitrogen is required. There are several formulations of foliar N. In some years, make applications based on tree performance and leaf analysis.

Table 10–4. Actual nitrogen rates per tree in sod culture

	ACTUAL NITROGEN per TREE (grams)		
YEAR or TREE AGE	Number of Trees/Ha (trees/ac)		
	400 (160)	500 (200)	600 (240)
Planting Year	0	0	0
1	40	40	40
2	80	80	80
3	120	120	120
4	160	160	160
5	200	200	180
6	240	240	240
7	280	280	260
8	320	320	280
9	360	360	300
10	400	400	320
11	440	400	320
12	480	400	320

Phosphorus (P)

Phosphorus is not required in large amounts by fruit trees. With few exceptions, the level of phosphorus in Ontario soils is adequate. Phosphorus does have a place for sod or cover crop maintenance. A soil test is the best way to determine if the sod needs this nutrient.

- If indicated by a soil test, apply phosphorus before planting an orchard when it can be thoroughly incorporated in the soil. Phosphorus soil test values between 12–20 ppm are considered adequate for establishing trees and producing fruit.

Potassium (K)

Potassium is important for fruit colour, winter hardiness, tree growth and disease resistance (fire blight in pears). An excess of potassium can lead to deficiency of magnesium (Mg), so avoid excessive rates of potassium. Potassium soil test values between 120–150 ppm are adequate when planting fruit trees. Muriate of potash (0-0-60) is the most common form of potassium. If leaf analysis data is not available the following rates can be considered normal.

Trees 1–6 years of age regardless of density

- Apply 50 g K_2O (80 g muriate of potash) per 2.5 cm of trunk cross-section (diameter).

Trees 7 years of age or older

- Apply no more than 3 kg of K_2O (5 kg muriate of potash) per mature standard tree in a year, regardless of how severe the deficiency. When the tree canopy has covered the space available, potassium fertilizer requirements level out and do not increase indefinitely with tree age. Again leaf analysis is the most reliable guide.

Placement and timing

- In early spring, apply potassium separately or combined with nitrogen. Some growers make fall applications because of time constraints in the spring. However, some of the potassium may be lost by leaching over winter. For this reason, apply in spring if possible.
- In sod orchards, apply potash in a band around the dripline or in the herbicide strip.

Foliar application of potassium

In dry growing seasons potassium is not readily available to the plant. Foliar applications of potassium may help where potassium deficiency is confirmed.

Magnesium (Mg)

Magnesium deficiency is becoming more evident in orchards, particularly when high rates of potash are used. Magnesium deficiency can lead to premature drop of fruit at harvest.

As magnesium is a part of the chlorophyll molecule, trees deficient in magnesium have older leaves that are pale in colour. Leaf analysis is the best way to evaluate magnesium needs.

Foliar sprays of magnesium are effective in correcting Mg deficiency for the current year only. For more permanent correction, soil applications of magnesium are required. Magnesium soil test values between 100–250 ppm are considered adequate when planting fruit trees. See Table 10–3, *Magnesium foliar sprays,* on page 173.

Fruit or foliage injury is possible from a mixture of pesticides with magnesium sulfate.

- Apply magnesium sulfate separately or try it on a few trees first. Check manufacturer's label regarding mixing magnesium chelates[1] with pesticides.
- For long-term corrections, apply magnesium to the soil. The response is not immediate. On some soil types a single early spring application of soil-applied magnesium does not work and a 2nd or 3rd application the following spring may be required before the magnesium level in the tree improves.
- To be sure that fruit drop is not a problem during this waiting period, apply foliar sprays the first 2 years, in addition to soil applications.
- For soil corrections, apply 5–7 kg/mature standard tree and 3–4 kg/mature dwarf tree of sulphate of potash magnesia. This is a granular fertilizer known by several trade names. It contains approximately 21% potash and 11% magnesium. Apply in early spring in a band under the tree dripline. It contains potassium (K) and the rate of application depends on potash needs. No further potash (e.g. 0-0-60) is needed, but apply nitrogen at recommended rates. Other sources of magnesium also work well as a soil application.
- If magnesium is being blended with the fertilizer, apply at least 80 kg of available magnesium per hectare when the fertilizer is spread.
- Use dolomitic limestone on acidic soils to raise the soil pH and to supply magnesium.

Calcium (Ca)

Lack of calcium is associated with fruit problems in pear, and gummosis in European plums and prunes. Some formulations of calcium chloride ($CaCl_2$) result in poor fruit finish if applied too close to harvest. Calcium sprays must contact the fruit for uptake to be effective; therefore water volumes capable of wetting the entire tree are required. The more calcium applied, the better the control; however excessive calcium can cause foliar burning. The product used is not as important as the total amount of actual (elemental) calcium applied.

Use $CaCl_2$ (77% flakes) at 4 kg/1,000 L of water from early July to mid-Aug. Apply 3 sprays, 10–12 days apart. For acceptable results up to 12 kg/ha of actual calcium is often required in a total of 4 or more sprays. Calcium sprays may injure foliage and fruit if applied during low temperature and wet weather. These conditions delay the drying of the spray. Injury can also occur if calcium is applied in hot (over 25°C) or humid weather. Do not apply calcium formulations containing nitrogen after the end of July or fruit quality and storability may suffer. For all formulations consult label directions for concentrations to use and compatibility with pesticides.

Micronutrients for Tender Fruit

Deficiencies of micronutrients or trace elements are not widespread in Ontario fruit plantings. The desirable range for micronutrients is quite narrow. More damage is possible with excess amounts rather than from deficiencies.

- For this reason, do not apply micronutrients to fruit crops unless leaf analysis or visible symptoms confirm a deficiency.
- Apply only the nutrient that is deficient in sufficient quantities to correct the problem.

Boron (B)

Boron deficiency occurs mainly on alkaline soils (pH greater than 6.5), acid soils (pH 3.5–4.5), dry soils, soils low in organic matter or on sandy knolls. Boron deficiency affects growth and fruiting.

There is currently no accredited soil test for boron in Ontario.

- Use a leaf analysis to check for boron deficiencies. Boron levels should be 20–60 ppm.

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[1] Use chelates recommended for foliar sprays.

- Where a boron deficiency is confirmed, apply boron to soil or in foliar applications. There are several sources of boron. Check the manufacturer's recommended rates and timing of applications.

Iron (Fe)

Iron deficiency is also called lime-induced chlorosis. As the soil pH rises over 7, or in heavily-limed soils, iron becomes unavailable to plants. Occasionally, a few plants may exhibit iron-deficiency symptoms. These are often located near the site of previous lime or building plaster storage where the soil pH is abnormally high. Iron deficiency may also occur in isolated parts of the field or on a few individual plants. Iron deficiency causes interveinal chlorosis of new leaves. As the condition worsens, the whole leaf becomes pale yellow. Quite often only one side or one branch of the tree is affected.

Currently there is no accredited soil test for iron in Ontario. Confirm a suspected deficiency with a foliar analysis. Generally, soil applications of inorganic iron sources are not effective in supplying iron to the crop. Iron chelates[1] make correction of iron deficiency relatively easy. These materials can be applied safely as foliar sprays. Consult manufacturer's label for information on rates and timing.

Manganese (Mn)

Manganese deficiency occurs occasionally in fruit-growing areas of Ontario. It is most prevalent in wet seasons or with high soil pH (alkaline conditions). In mild cases of deficiency, there is a yellowing of the interveinal leaf areas of young leaves near the shoot-tip.

- In addition to leaf analysis, use soil tests to determine the status of manganese in the soil. OMAF soil manganese index values greater than 8 should provide adequate manganese to the crop.
- If manganese is required, apply as a foliar spray of manganese sulphate or chelate.[1]
- Use manganese sulphate with a spreader sticker.
- Consult manufacturer's label for complete information on rates and timing.

Soil applications of manganese are not effective.

Manganese toxicity

On some peach cultivars manganese toxicity can occur on coarse-textured soils when the soil is very acid (pH below 5.0). The symptoms known as "measles" are raised pimples on the bark underlain by dark brown spots. Other symptoms that may be observed are leaf chlorosis, tip dieback, early leaf abscission, reduced flower bud development and shoot growth. Correction is sometimes possible by adding lime to raise the soil pH. If possible, work into the soil. Prior to orchard planting, sample the soil and add lime if pH is low.

Zinc (Zn)

Zinc deficiency symptoms include short internodes, small narrow leaves and interveinal chlorosis with shoot and branch dieback. In advanced stages, small, narrow terminal leaves are arranged in whorls or "rosettes." This results in the typical "rosette" and "little leaf" description for zinc deficiency. Use leaf analysis and soil tests to test for zinc deficiency. An OMAF soil zinc index value greater than 8 should provide adequate zinc to the crop. Where a zinc deficiency is confirmed, check manufacturer's recommended rates and timing of applications of zinc products.

Warning: Do not concentrate nutrient sprays.

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[1] Use chelates recommended for foliar sprays.

NOTES ON STONE FRUIT DISEASES

Brown rot control

Development of resistance

Repeated use of fungicides from the same chemical "family" or group can lead to the development of fungicide resistant strains. This was the case with the benzimidazole family of fungicides. (See Table 10–5, *Chemical families of fungicides for tender fruit*, on page 178.)

Benlate and Senator are chemically-related fungicides. These products gave superior control of brown rot in the past. Frequent, and sometimes almost exclusive use of Benlate in the 1970s, created Benlate-resistant forms of the brown rot fungus in many stone fruit orchards in the Niagara region. This type of resistance has remained quite stable in the field for the last 20 years. Although Benlate is no longer registered for use in Canada, benlate-resistant fungi are also resistant to Senator.

Depending on the crop and crop stage of development, other products in different families of fungicides are available for brown rot control. The key to limiting the development of resistance is to know the chemical families of the products you are using and, where possible, rotate use between different families and between different modes of action.

Rovral gives superior control of brown rot on cherries and peaches. Rovral has some post-infection activity and also reduces new spore production on established lesions. Rovral-resistant forms of the brown rot fungus can be easily selected in the laboratory, and resistance could occur also in the orchard. Rovral-resistant forms of brown rot have been found in the field in New Zealand but not in surveys conducted in 1995–96 in Ontario.

Vangard was registered in North America in 1998. It had been registered previously in Europe for use on grapes for botrytis bunch rot and brown rot on stone fruit. Botrytis has already developed resistance to this product in Europe and the risk of resistance developing is expected to be similarly high for brown rot.

Indar, although used on tender fruit in the U.S. for some time, is a relatively new brown rot fungicide in Ontario. This fungicide has consistently performed extremely well against brown rot in the U.S. industry.

Management of resistance

- Limit Rovral to only 1–2 applications per season to delay possible development of brown rot resistance to Rovral and cross-resistance to Botran and Ronilan.
- Apply Rovral when the crop is most susceptible to infection, such as at bloom and immediately preharvest, and use less effective materials when there is reduced risk of infection.
- Take extreme caution not to overuse Vangard. Limit its use to 2 applications per season and never use in consecutive or back-to-back sprays.
- Alternate fungicides to minimize resistance development.
- Use Indar in a managed fungicide rotation to lessen the chance of resistance developing to this product.

Bravo, Sulfur and Captan and Maestro are protective fungicides. Brown rot has not developed resistance to these products. Sulfur is not widely recommended because it is a skin irritant and it kills beneficial mites. Captan and Maestro are particularly valuable in programs designed to delay the development of fungicide resistance. Alternate these products with other fungicides to limit the use of resistance-prone fungicides such as Rovral and Vangard. A disadvantage of Captan or Maestro is that they can cause phytotoxicity to a few sweet cherry cultivars (e.g., Schmidt, Stanley prune and Japanese plums).

In order to manage resistance it is important to:

- minimize the number of applications per season per chemical group (see Table 10–5, *Chemical families of fungicides for tender fruit*, on page 178)
- rotate between different chemical families
- apply fungicides before an infection period, not as a clean-up spray after an infection has occurred.

Sharka (plum pox virus) of stone fruits

Sharka or plum pox virus (PPV) is a serious disease of stone fruit. It has spread throughout many European countries resulting in significant economic losses. The "D" strain of Sharka has been found in several orchards in Ontario, Pennsylvania and Nova Scotia. This strain of Sharka can naturally infect most cultivated fruit tree species of the genus *Prunus* including apricot, common plum, Japanese plum, peach and nectarine, but not sweet or sour cherry.

The plum pox virus is transmitted from infected hosts to previously uninfected plants by aphids over short distances. Long distance spread of the virus occurs from transport of diseased budwood and other propagation material.

Symptoms vary and may not appear on infected trees for several years after infection. Symptoms may appear on only a few branches, leaves or fruit. Leaf symptoms include light chlorotic or yellow rings, spots, blotches and line patterns often along veins, and vein clearing. Severely infected leaves may be twisted, curled and distorted.

Symptoms of PPV on peach and nectarine fruit first appear as faint mottled yellow lines, patches and rings on green fruit. As the fruit matures, the lines, patches and rings remain yellow surrounded by the normal ripe coloration. Some fruit on the same infected tree may have no symptoms while other fruit are severely diseased. The sugar content is also affected in some cultivars.

Severely diseased plum and apricot fruit are pocked with dark, sunken rings and appear severely deformed. Rings and spots are occasionally seen on the pits of infected apricot fruit sometimes displaying no other external symptoms. In Europe, yield losses between 20%–30% have been reported on susceptible plum varieties.

Infected trees rarely die but frequently become less productive as the disease progresses. Fruit may drop 20–30 days prematurely depending on the host species, cultivar and PPV strain.

Sharka must be eradicated before it becomes established in stone fruit-producing regions. There are no commercially available varieties resistant to Sharka. Because migrant aphids can quickly acquire and transmit the virus, insecticide applications to control aphids do not reduce the spread of disease. Insecticides to control aphids also reduce populations of beneficial insect predators and are not IPM compatible. A protocol to eradicate plum pox from Canada is currently being implemented by the Canadian Food Inspection Agency. The eradication protocol involves surveying orchards and nurseries regularly and immediately removing infected trees or entire orchard blocks before the virus spreads.

Research indicates that aphids can transmit the virus from infected fruit to young trees. In PPV infected regions, dispose of fruit so that it is not available to aphids by cultivating and burying cull piles or covering with a plastic tarp. Keep cull piles away from susceptible Prunus trees and destroy all volunteer seedlings.

For more information see the OMAF web site at www.omaf.gov.on.ca and OMAF Factsheet Sharka (Plum Pox Virus) of Stone Fruit and Ornamental Species, Order No. 02-001.

TABLE 10–5. Chemical families of fungicides for tender fruit

Family group	Chemical family or group	Product name	Risk of resistance mode of action	Restrict number of applications*/season to slow development of resistance
1	MBC	Senator 75 DF Benlate Mertec SC	high, single site	high level of resistance; no longer recommended (if no resistance 2 applications/season)
2	Dicarboximides	Rovral WP Ronilan EG	medium, single site	1–2 applications/season
3	Demethylation Inhibitors (S.Is)	Nova 40W Topas 250E Funginex 190 EC Indar 75WSP	medium, multiple gene mediated	2–3 applications/season
7	Carboxamides	Lance WDG	medium	
9	Anilinopyrimidines	Vangard 75 WG	high, single site	2 applications/season; do not use in consecutive or back to back sprays
11	Strobilurins	Cabrio EG Flint 50 WG	high, single site and multistep	2 applications/season
14	Chlorophenyl	Botran 75W	low, multiple site	2 application/season
M	Inorganic	Kumulus DF Microscopic Sulphur	low, multiple site	number of maximum applications has not been set
M	Phthalimide	Captan 80 WDG Maestro 80DF	low, multiple site	number of maximum applications has not been set
M	Chloronitrile	Bravo 500	low, multiple site	1–3 applications/season

* Restrictions based on label and/or scientific literature.

TABLE 10-6. Effect and activity of fungicides on stone fruit diseases

Use fungicides only for diseases listed on the product label for the crop and for the disease.

								Registered for use on:			
Brand Name	**Brown rot Blossom blight**	**Brown rot fruit phase**	**Rhizopus rot**	**Cherry leaf spot**	**Powdery mildew**	**Black knot**	**Peach leaf curl**	**Apricots**	**Cherries**	**Peaches**	**Plums**
Bravo 500	+++	X	X	++++	0	++++	++++		✓	✓	
Cabrio EG	++	++	?	?	++++	?	X	✓	✓	✓	✓
Captan 80 WDG	+++	+++	+	+++	0	++	+++	✓	✓	✓	✓
Copper 53W	X	X	X	+++	++	X	++		✓*	✓	
Elevate 50 WDG	+++	+++	0	0	0	0	0		✓	✓	
Ferbam 76 WDG	0	0	X	++	0	0	++++	✓	✓	✓	✓
Funginex 190 EC	+++	X	X	+++	+++	0	0		✓	✓	✓
Indar 75 WSP	++++	++++	?	+++	+++	++	X	✓	✓	✓	✓
Kumulus DF	++	+	0	+	++	+ to ++	X		✓	✓	✓
Lance WDG	++++	++++	0	?	++	?	X	✓	✓	✓	✓
Maestro 80 DF	+++	+++	+	+++	0	++	+++	✓	✓	✓	✓
Nova 40 W	+	X	0	+++	++++	0	X		✓	✓	✓
Rovral	++++	++++	++++	++	?	0	X	✓	✓	✓	✓
Microscopic Sulfur	++	+	0	+	++	+ to ++	X		✓	✓	✓
Topas 250E	++++	++++	++++	+++	+++	++	X	✓	✓	✓	✓
Vangard 75 DF	+++	+++	+++	?	0	0	X	✓		✓	✓

✓ registered on the crop X not used at this timing for this pest * Sour cherry only

Legend

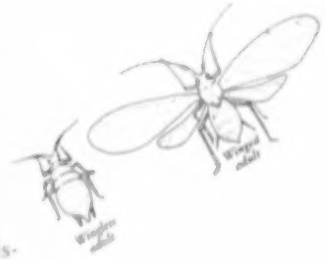
0 = not effective + = slight ++ = fair +++ = good ++++ = very good ? = unknown

Source: McSmith Research Services

NOTES ON INSECTS AND MITES

Aphids

Identification



Aphids can weaken plants by removing sap, causing wilting, curling, or yellowing. Many spread diseases. They are often found in colonies, usually on the underside of leaves. They excrete a substance called "honeydew" that promotes development of black sooty mould on leaf and fruit tissues.

Aphids have complex life cycles. They may have winged or wingless forms. Winged aphids are associated with migration from one crop or host plant to another. Aphid populations can increase rapidly by asexual reproduction. Females can give birth to live young. For most of the year this means all individuals feeding on plants are females.

Period of activity

In Ontario many aphid species overwinter in the egg stage on primary hosts. In the spring the egg hatches and produces wingless offspring. These reproduce without mating, producing several generations of wingless females. When populations develop to high densities, or when hosts begin to die back or mature, winged forms are produced and migrate to secondary hosts. In the fall, when temperatures drop and day length shortens, or when the plants slow their growth or die, winged forms are once again produced. These fly back to primary hosts where they mate, lay eggs and die.

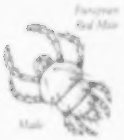
Monitoring and thresholds

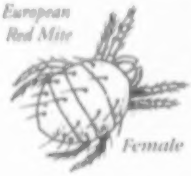
Peaches can tolerate infestations of up to 30% of their terminals or 20 colonies/tree. The threshold for control in nectarines is much lower at 10% terminal infestation (5–10 colonies/tree). Consider the presence or absence of predators before spraying. Most growers choose not to control aphids in bearing trees, except in extreme situations.

Mites

Identification

European red mite (ERM), two-spotted spider mite (TSSM), pear rust mite and pear leaf blister mite are potentially serious orchard pests.

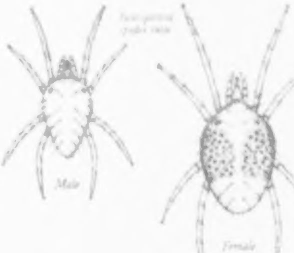




Mites are small and are best counted and identified with a microscope. Nymphs have 3 pairs of legs while adults possess 4 pairs. Female ERM are bright red (males are a dull greenish-brown) with white spots and 6–8 hairs. Two-spotted spider mites are pale green to straw coloured, with 2 dark spots on their backs. High populations of two-spotted spider mites produce a characteristic webbing on the underside of leaves.

ERM and two-spotted mites remove sap, chlorophyll, and nitrogen from leaves. High populations cause a condition called "bronzing". Prolonged feeding, particularly if populations are heavy in early to mid-summer, leads to a reduction in shoot growth and fruit bud set the following year. Fruit colour, soluble solids, firmness and size can also be affected.

Period of activity



ERM overwinter as eggs on the bark of trees. Two-spotted spider mites overwinter as adults on bark, on weeds and on orchard debris. Development of mites is correlated to temperature. From egg to adult takes 7 days at 27°C, and 40 days at 13°C. There are several generations per year.

Monitoring and thresholds

Count mites by examining field-collected leaves under a microscope or with a 16X hand lens. Include the total number of eggs, nymphs and adults in the count. Loring and Babygold are useful indicator cultivars. See Table 10–7, *Thresholds for ERM and TSSM on peaches*, page 181.

Management notes

Miticides can be effective against mite eggs, nymphs or both. Apply Superior Oil in early spring to control overwintering ERM eggs on sour cherries, peaches, and pears (see product label for timing on different fruit crops). This spray is especially important in blocks where pyrethroids are used for control of other orchard pests. Critical timing for summer miticide applications, when thresholds are reached, is in early July.

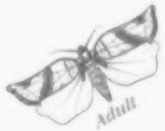
For more information, see OMAF Factsheet *Mite Pests and Their Predators in Ontario Orchards*, Order No. 95-057.

TABLE 10–7. Thresholds for ERM and TSSM on peaches

Stage of crop development	Threshold (in absence of predators)	Comments
Petal fall to 21 days after calyx	5–7 active mites/leaf	Foliage still young and expanding
June to mid-July	7–10 active mites/leaf	Control earlier if bronzing appears in the outer leaf canopy before this threshold is reached
Early July	10–15 active mites/leaf	Abide by preharvest intervals
Postharvest	50 mites/leaf	
Non-bearing	30 mites/leaf	

Obliquebanded leafroller

Identification



Adults are small, tan-coloured moths with 3 darker oblique bands on the front wings. Larvae are green with black (instar 1–3) or brown (instar 4–5) heads. Later instar feed inside tightly rolled leaves, and wriggle violently when disturbed.

OBLR larvae can cause significant damage by feeding on the fruit during the shuck-fall period. They tie nearby leaves to the surface of fruit and feed on the fruit skin. OBLR larvae do not tunnel into the fruit, and prefer split-pit varieties.

Period of activity

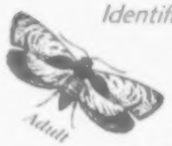
OBLR overwinter as partially grown larvae in special cocoons under old bud scales or bark of apple, pear, cherry and several other woody hosts. Larvae emerge in the spring and feed on the bud clusters, flowers, expanding leaves and developing fruit. OBLR does not successfully overwinter on peach, nectarine, or apricot because of cyanide content in the leaves. Early season damage in these crops is usually the result of overwintering larvae blown in from adjacent blocks of preferred hosts. Overwintering larvae complete their development and emerge as moths from mid-June through mid-July. The adult moths mate and their progeny, first generation larvae, complete development from late-July through late-August. This generation feeds on both foliage and fruit. There are 2 generations per year in Ontario.

Monitoring and thresholds

OBLR has not been a significant problem on peach and nectarine since a resistance management program for OFM was introduced. Pyrethroid use and timing for 2nd–4th generation OFM appears to control OBLR. However, OBLR can be a serious problem in apricot. Monitoring and controlling leafroller populations in surrounding crops such as sweet cherry, apple, and pear can reduce pest pressure. Sampling involves checking shoots and fruit spurs from tight cluster through to petal fall, and from first cover to harvest.

Oriental fruit moth

Identification



The oriental fruit moth (OFM) is one of the most serious pests of stone fruit in Ontario. A successful resistance management strategy exists for the control of this pest in peaches and nectarines.

The adult OFM is a small, dark grey moth (8–10 mm long), with wavy, light grey bands. Mature larvae have a brown head capsule, 3 pairs of legs and a distinct pink body.

Period of activity

OFM larvae attack new terminals and fruit. Infested shoots wilt, developing a condition called "flagging" that is easily detected in the field. First generation larvae typically attack developing shoots. Subsequent generations (2nd–4th) attack fruitlets or ripe fruit. Fruit infested early in the season usually drop. Fruit injury can be conspicuous, with frass or gum exuding from the point of entry. Close to harvest, injury is often concealed, with entry occurring beside the stem.

Pears can be attacked by the second generation of OFM (early July) and by later generations. Pears are particularly vulnerable as fruit begins to ripen.

The OFM overwinters as a mature larva in tree bark and orchard debris. Other sources of infestation include fruit baskets and packing barns. There are 3–4 generations per year in Ontario.

Monitoring and thresholds

Use pheromone-baited traps to monitor emergence, flight and peak activity of male OFM. Spray at egg hatch, usually 3–6 days after peak flight is indicated from regional trap catches. The damage potential is too high to set a threshold based on trap catch. Examine shoots and fruit 7–10 days after a spray application to evaluate control.

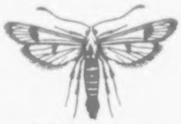
Management notes

Mating disruption (MD) products are available for management of OFM. Mating disruption is a pest management technique that uses pheromones (communication chemicals) distributed throughout an area either by hand-applied dispensers or in a sprayable product. By introducing many sources of the sex pheromone into the ecosystem, the probability of the male finding the female is reduced, as is the likelihood of successful mating. As a result, mating is either delayed or prevented. Consequently, the subsequent population is reduced, and fewer larvae are present to cause crop damage.

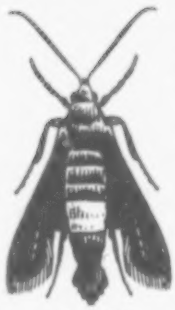
Mating disruption is pest-specific and is completely safe for workers and beneficial organisms. Using this technology requires specific knowledge and management practices. You must monitor throughout the season for OFM and secondary pests but you may also find that reduced pesticide use allows beneficial insects to maintain secondary pests at acceptable levels. For more information on mating disruption, see OMAF Factsheet *Mating Disruption for Management of Insect Pests*, Order No. 03-079 and OMAF infosheet *Mating Disruption with Isomate M100* at *www.omaf.gov.on.ca*.

Peachtree borers

Identification


Male Peachtree Borer

Peachtree borer (PTB) larvae damage stone fruit trees by boring into trunks and branches, feeding on the growing tissue (cambium) and inner bark. The PTB confines its activities to the trunk area; feeding can completely girdle and kill young trees. Larvae of the Lesser Peachtree Borer (LPTB) are associated with previously damaged or diseased plant tissues, including cankers, pruning wounds, and winter- and insect-injured areas.


Female Peachtree Borer

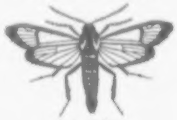
Period of activity

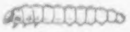
Both species overwinter as larvae. The PTB completes its development in the summer, with adult moths emerging from July through September. Emergence pattern of the LPTB is prolonged and less synchronous, and occurs from late May through September. (Peaks occur from June through July.)

Monitoring

Pheromone traps are used to monitor the emergence of male moths throughout the season. In areas with high peachtree borer pressure (southwestern Ontario), controls are timed to coincide with peak moth activity. Monitor trees for the presence and abundance of peachtree borers. Examine trees for the presence of sawdust-like frass and exuded gum. The pupal cases of emerged moths can often be found near the surface of damaged tissues.

Lesser Peachtree Borer


Adult

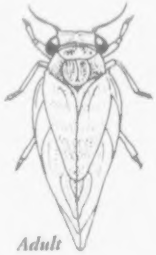

Larva

Management notes

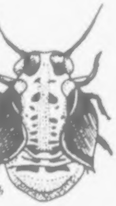
Lesser peachtree borer and peachtree borer can be serious problems in apricot blocks. Redirect a nozzle when spraying insecticides for plum curculio and preharvest cover sprays. This provides spray coverage of the trunks and lower scaffolds.

Pear psylla

Identification


Adult

Adults are small, (2 mm) reddish-brown with 4 membranous wings. They lay elongated white-yellow eggs. Nymphs are flattened, passing through 5 instars before the adult stage. Youngest nymphs are yellow, then green. Older nymphs have sturdy wingpads and are black in colour. All stages have piercing sucking mouthparts and produce sticky honeydew as they feed.


Nymph

Period of activity

Pear psylla adults overwinter in cracks of tree bark or under debris. Adults become active when temperatures reach 10°C. Mating and egg laying occur prior to bud break. There are 2–3 generations per year in Ontario.

Monitoring and thresholds

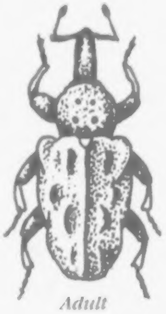
Examine samples of fruit spurs in early March to provide an indication of potential pest pressure. From mid-April through to harvest examine spurs, new terminals and water sprouts weekly for eggs, nymphs and adults. Tapping trays are useful for monitoring adults. Collect at least 25 fruit spurs and terminals (1/tree) per orchard. Table 10–8, *Thresholds for pear psylla* provides thresholds for control. See OMAF Factsheet *Pear Psylla in Ontario Pear Orchards*, Order No. 90-101 for more information on monitoring.

TABLE 10–8. Thresholds for pear psylla

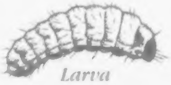
Stage of crop development	Decision/threshold
Delayed dormant	Depends on previous history, adults present, egg laying started
White bud stage	10 eggs or more/spur with hatching started
Immediately at petal fall	10 actives/spur & majority of eggs hatched
Emergency summer spray #1	5–10 actives/sucker
Emergency summer spray #2	20 actives/sucker with low predator population; stickiness and fruit loss imminent

Plum curculio

Identification



Adult



Larva

Plum curculio (PC) is a small (6 mm), rough, grey-brown weevil that creates a characteristic crescent-shaped egg-laying scar on the surface of fruit. New egg-laying scars reveal moist fruit flesh while older scars are calloused and brown. PC larvae feed inside the fruit and are sometimes confused with OFM. However, they do not leave the frass that is typically found in the entry wound created by OFM larvae. Like OFM, PC leave a 'clean exit hole'.

Period of activity

Plum curculio adults overwinter in wooded areas adjacent to orchards. They become active in the spring after warm weather and rain. Adults emerge over a 3–6 week period beginning just after bloom. Egg laying and fruit injuries begin within 2 weeks of emergence.

Monitoring and thresholds

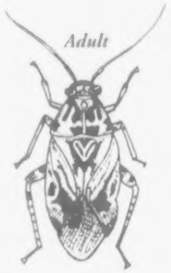
Apricots, cherries and plums located along borders of an orchard are good indicator plants for PC activity. Observe fruit along the outside 2–3 rows of the orchard next to wild hosts. Apply controls when new injury is found. Monitor 5–7 days following insecticide application to determine the need for reapplication. The best way to limit PC damage is to set up a rigorous monitoring program in areas with previous damage. When conditions are right in the spring, check developing fruit frequently and carefully, or enlist the services of a crop consultant. PC is quite sporadic and often confined to border areas.

Management notes

Since these insects often enter orchards from rough or bush areas, a border spray of 2–4 rows may provide sufficient control. The window for control for PC is narrow. Problems can become worse each year if the pest is not adequately controlled. The first spray for oriental fruit moth often (but not always) comes at a good time for control of PC. However, adult PC emerge over a long period and are actively laying eggs for more than a month. Ongoing monitoring for new damage is the key to successful control.

Tarnished plant bug

Identification



Tarnished plant bugs (TPB) have piercing sucking mouthparts used to sting fruit. Feeding kills plant cells and, as a result, fruit is deformed as it continues to grow. Damaged fruitlets may also exude a clear gummy substance. Pest injury varies between site and cultivar.

Period of activity

Humid, hot, windy, or dry weather can promote TPB migration from weedy alternate hosts or crops into orchard blocks.Adult TPB overwinter under leaf debris, bark, logs, and under broadleaf weed litter. They become active on warm days early in the spring and may attack developing buds and fruitlets. In late spring (early May and June), they migrate to herbaceous weeds, flowers and vegetables, where they lay eggs into stems and stalks.

Monitoring and thresholds

Use sweep nets to monitor TPB on weedy hosts. Monitor the development of nymphs through the later instars. When new summer adults appear, start to watch for fruit injury. Monitor fruit for damage by sampling a minimum of 100 fruit/block. Border sprays are warranted when 2% of fruit, collected from the edge of the orchard, are damaged. Apply a second spray, to the entire block, when injury levels reach 2%–5% throughout the block.

Management notes

Cover crop management is important to prevent tarnished plant bugs from moving into trees at critical points in plant development. Use these management practices, together with insecticides, to minimize the size of TPB populations within the orchard and to provide an alternate food source for the summer generations of migrant plant bugs.

- Remove any large oak trees adjacent to peach blocks to avoid oak bug injury. White and red oaks are more important than the Burr type.
- Apply a contact herbicide in the herbicide strip to early season hosts of plant bug which are mainly mint, creeping charlie, and annual and perennial chickweed. In most years, apply herbicide by about April 20 in southwestern Ontario and May 1 in the Niagara Peninsula.
- Apply a second herbicide, such as a contact plus residual, to the herbicide strip in the latter part of May to provide season-long control of weeds in your orchard.
- Where clean cultivation is practised, begin as early as possible and continue up to about May 15 in southwestern Ontario and June 1 in the Niagara Peninsula. Early cultivation reduces the number of resident plant bugs. Stop cultivation in June to encourage weeds such as pigweed and lamb's-quarters to establish. These provide an alternate food source for first generation plant bugs, discouraging feeding on peach fruit.
- In sod culture, mow frequently, e.g. every 2 weeks. Use fertilizer and herbicides as needed to encourage weed-free sod. Creeping red fescue or other grasses are the preferred species for sod. Avoid clover.
- If you use cover crops in cultivated peach orchards to lower nitrogen levels and check tree growth, delay preparing and sowing of the cover crop until July 10, when the major danger of extensive plant bug injury is over.

Visit the tender fruit page on the OMAF web site at *www.omaf.gov.on.ca*.

APRICOT CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 10–9, *Days to harvest intervals for products used on apricots*, on page 186.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant (in late March or early April before buds swell)			
European red mite	• Superior "70" Oil	20 L/1,000 L water	Apply in a high volume spray to ensure thorough coverage. Do not apply Captan or Maestro within 14 days of oil.
Prebloom (when blossom buds show pink)			
Brown rot Blossom blight	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [5]Vangard 75 WG • [2]Indar 75 WSP • [1]Lance WDG	500 mL 1.50 kg 4.50 kg 4.50 kg 370 g 140 g 370 g	Apricots are extremely susceptible to brown rot at blossom time and just before picking. To avoid resistance, do not apply Topas, Rovral, Indar, Lance or Vangard more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44.
DO NOT APPLY INSECTICIDES WHILE APRICOT TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.			
Shuck split (when about 50% of shucks have split)			
Brown rot	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [5]Vangard 75 WG • [2]Indar 75 WSP • [1]Lance WDG	500 mL 1.50 kg 4.50 kg 4.50 kg 370 g 140 g 370 g	Apricots are extremely susceptible to brown rot. To avoid resistance, do not apply Topas, Rovral, Indar, Lance or Vangard more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44.
Plum curculio	• [9]Guthion Solupak or [9]Sniper • Sevin XLR Plus	see label see label 6.25 L	Apricots are very susceptible to plum curculio. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg laying scars. Damage often occurs only on the border of the orchard. Check developing fruit for new damage 7–10 days after insecticide is applied.
Shuck fall (10–12 days after last spray)			
Brown rot	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [5]Vangard 75 WG • [2]Indar 75 WSP • [1]Lance WDG	500 mL 1.50 kg 4.50 kg 4.50 kg 370 g 140 g 370 g	Choose a different product than used previously this season. Rotate products from different families, see Table 4–2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
Plum curculio	• [9]Guthion Solupak or [9]Sniper • Sevin XLR Plus	see label see label 6.25 L	
Lesser peachtree borer Peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4 EC • Sevin XLR Plus	1.50 kg/1,000 L 1.50 kg/1,000 L 1.75 L/1,000 L 6.25 L	Peachtree borers are sporadic pests. In areas with high borer populations, follow this spray regime. Use pheromone traps to monitor adult activity and begin sprays at first flight. Make 3 applications at 5–10 day intervals. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Check the days-to-harvest interval.
First cover (10–12 days after Shuck fall)			
Brown rot	Use one of the fungicides listed under **Shuck split**.		
Plum curculio	Use one of the insecticides listed for plum curculio at **Shuck split**.		

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Special sprays			
European red mite	• Kelthane 50 W	3.25 kg	European red mite is a sporadic pest and is rarely a problem in apricot orchards. Apply when mites build up to 10 active stages/leaf. Do not apply Kelthane more than once/season.
Leafrollers	• Dipel 2X DF • [2,9]Success 480 SC	1.12 kg 182 mL	
Prepick to harvest			
Brown rot	Use one of the fungicides listed under **Shuck split**.		Apricots are extremely susceptible to brown rot just before picking. Additional sprays may be required during harvest if conditions are wet. The label rate for Vangard at this time is 740 g/ha.

NOTES ON APRICOT DISEASES

Bacterial spot

Bacterial spot can be serious on some apricot cultivars, usually during wet seasons. Leaves, fruit and shoots may develop symptoms. Lesions on leaves appear initially as water soaked areas confined by leaf veins. Eventually the lesions darken and the centers of the lesions fall out giving the leaves a tattered or "shot hole" appearance. Lesions on fruit develop pits and cracks that may coalesce to affect large areas of the fruit surface. Cankers may also develop on shoots. The best defense against this disease is planting resistant cultivars (see OMAF Factsheet *Apricot Cultivars*, Order No. 02-035). There is no satisfactory chemical option for control of bacterial spot during the cropping season.

Verticillium wilt

Verticillium wilt is a disease caused by a soilborne fungus. It infects through the roots and plugs the vascular or water- conducting tissue. Apricots are particularly susceptible to this disease. Initially, leaves wilt on one or more branches along one side of the tree. These early symptoms develop with the first hot weather of the season. Affected sapwood is stained dark brown or black. Verticillium wilt is more likely to occur if apricots are planted where highly susceptible crops such as tomatoes, strawberries, potatoes, eggplants, melons, squash or peppers were grown and infected with the disease. The fungus can persist in soil for many years. Avoid planting apricots in areas where susceptible crops were grown for a number of years and do not interplant with these crops.

TABLE 10–9. Days to harvest intervals for products used on apricots

Use this table as a guid[illegible]ut refer to product label for specific information. The preharvest interval is the minimum number of days between the last spray and first harvest.

Product name	Preharvest interval (days)
Supra Captan 80 WDG	2
Dipel 2X DF	1
Endosulfan 50W	15
Guthion Solupak	21
Indar 75 WSP	1
Kelthane 50 W	14
Lance WDG	1
Maestro 80 DF	2
Rovral	1
Sevin XLR Plus	5
Sniper	21
Success 480 SC	14
Superior "70" Oil	Prebloom only
Thiodan 50 WP	15
Thiodan 4EC	15
Topas 250E	3
Vangard 75 WG	2

See *Notes on Stone Fruit Diseases* on page 177.
See *Notes on Insects and Mites* on page 180.

SOUR CHERRY CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 10-10, *Days to harvest intervals for products used on sour cherries*, on page 189.

Diseases and Insects	Materials	Amount/ha	Comments
Prebloom			
European red mite	• Superior "70" Oil	20 L/1,000 L water	Only needed in sour cherry orchards with a heavy mite population. Spray as buds are breaking. Mature trees require water volumes of approximately 3,000 L/ha for thorough coverage. Do not apply Captan, Maestro or Bravo within 14 days of oil.
Bloom			
	DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. **SEE BEE POISONING ON PAGE 64.**		
Brown rot (stem rot and blossom blight stages)	• [5]Topas 250 E • Nova 40 W • [2]Rovral • [4]Bravo 500 • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Funginex 190 EC • Kumulus DF • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 340 g 1.50 kg 7.00 L 4.50 kg 4.50 kg 2.50 L 22.50 kg 1.70 kg 370 g 140 g	Spray just before blooms open if weather conditions are expected to be wet and warm (above 16°C) during bloom. Sour cherries are less susceptible to brown rot than sweet cherries. One application during bloom should be sufficient, unless frequent wet periods occur and brown rot pressure is high. Do not use Captan or Maestro within 14 days of an oil application. To avoid resistance do not apply Topas, Rovral, Elevate, Indar or Lance more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Nova and Topas are absorbed by flower parts, making these materials more rainfast than other protectant fungicides. Topas also suppresses black knot.
Petal fall			
Leaf spot	• [4]Bravo 500 • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Nova 40 W • Ferbam 76 WDG • Equal 65 WP • [5]Topas 250E	7.00 L 4.50 kg 4.50 kg 340 g see label 2.25 kg 500 mL	Spray only if rain is forecast between **Bloom** and **Shuck sprays**. Make no more than 4 applications of Nova/season. Apply 1 application of Bravo 500 to control early season leaf spot. After **Shuck split** rotate with other products as a resistance management strategy. Alternate fungicides from different chemical families. See Table 4-2, *Fungicide/bactericide groupings based on sites of action*, on page 47.
Black knot	• [4]Bravo 500 • [2]Indar 75 WSP	7.00 L 140 g	This spray is only needed on sour cherry orchards with a history of black knot. Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. Do not apply Bravo 500 after **Shuck split** to avoid fruit injury.
Shuck			
Plum curculio	• [9]Guthion Solupak or [9]Sniper • [3]Zolone Flo • Imidan 50 WP	see label see label 2.00 L 3.75 kg	Spray when most shucks are off and plum curculio activity is observed. Zolone also helps control aphids. Make no more than 3 applications of Zolone Flo/season.

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[1] *Minimum period for re-entry is 4 hr.* [2] *Minimum period for re-entry is 12 hr.* [3] *Minimum period for re-entry is 24 hr.* [4] *Minimum period for re-entry is 48 hr.*
[5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.*
[8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*

Diseases and Insects	Materials	Amount/ha	Comments
Brown rot	• [5]Topas 250E • [4]Bravo 500 • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Rovral • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 7.00 L 4.50 kg 4.50 kg 1.50 kg 1.70 kg 370 g 140 g	To avoid resistance, do not apply Topas, Rovral, Elevate, Indar, or Lance more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. Topas will also suppress black knot.
Leaf spot	Use one of the fungicides recommended at **Petal fall** with the exception of Ferbam.		
European red mite	• Kelthane 50 W	3.25 kg	Thorough coverage is necessary for good mite control. Only needed in heavily infested sour cherry orchards.
Black knot	• [4]Bravo 500 • [2]Indar 75 WSP	7.00 L 140 g	This spray is only needed on sour cherry orchards with a history of black knot. Prune out, remove and burn all black knots from commercial orchards during dormant period before bud break. Remove any wild infected cherry hosts surrounding commercial orchards. Do not apply Bravo 500 after **Shuck split** to avoid fruit injury.
First cover (12 days after shuck)			
Plum curculio	Use one of the insecticides listed under **Shuck**.		Monitor 7 days after the insecticide at shuck fall for new plum curculio damage. If crescent-shape cuts on fruit are found, then apply an insecticide. Zolone helps control aphids.
Leaf spot	Use one of the fungicides listed under **Petal fall** with the exception of Ferbam.		
Second cover (12 days after First cover)			
Cherry fruit fly Plum curculio	• [9]Guthion Solupak or [9]Sniper • Diazinon 50 W • [3]Zolone Flo • Imidan 50 WP	see label see label 3.00 kg 2.00 L 3.75 kg	On early varieties, check interval from last spray to harvest date. Spray when early varieties are beginning to colour. Diazinon is not labelled for and will not adequately control plum curculio. Zolone provides 12–14 days protection against cherry fruit fly while Diazinon provides 10 days. Make no more than 3 applications of Zolone Flo/season.
Leaf spot	Use one of the fungicides recommended at **Petal fall** with the exception of Ferbam.		
Powdery mildew	• Nova 40 W • Kumulus DF • [9]Cabrio EG	340 g 12.00 kg 670 g	Make no more than 4 applications of Nova/season. Kumulus at this rate suppresses powdery mildew. Higher rates may cause injury. Make no more than 2 consecutive applications of Cabrio, then alternate with fungicides from different families. See Table 4–2 on page 47. Cabrio will also suppress brown rot.
Third cover			
Cherry fruit fly	• Sevin XLR Plus • Imidan 50 WP • [3]Zolone Flo • Diazinon 50 W	6.25 L 3.75 kg 2.00 L 3.00 kg	Spray sour cherries about the time Montmorency is turning pink. Sevin provides 5–7 days protection. Make no more than 3 applications of Zolone Flo/season.
Leaf spot	Use one of the fungicides listed under **Petal fall** with the exception of Ferbam.		
Preharvest			
Brown rot	Use one of the fungicides listed under bloom except Funginex		
Postharvest			
Leaf spot	• [4]Bravo 500 • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Nova 40 W • Ferbam 76 WDG • Equal 65 WP	7.00 L 4.50 kg 4.50 kg 340 g see label 2.25 kg	Necessary where leaf spot is a problem. Make no more than 4 applications of Nova/season.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	• [9]Cabrio EG	670 g	Make no more than 2 consecutive applications of Cabrio, then alternate with fungicides from different families. See Table 4–2 on page 47. Cabrio will also suppress brown rot.
European red mite	• Kelthane 50 W	3.25 kg	If pest mites can easily be found on the leaves at this time, and predator mites are not present, add a miticide with your fungicide application.
Special sprays			
Aphids	• Diazinon 50 W • Thiodan 50 WP or Endosulfan 50W • [5]Zolone Flo	3.00 kg 3.25 kg 3.25 kg 2.00 L	These may be added to a compatible spray after bloom. Thorough coverage and a calm, warm day are necessary for good aphid control. Make no more than 3 applications of Zolone Flo/season. Zolone Flo and Diazinon 50 W are registered for black cherry aphid only.
Peachtree borer	• Thiodan 50 WP or Thionex 50 WP or Endosulfan 50W • Sevin XLR Plus	1.5 kg/1,000 L 1.5 kg/1,000 L 1.5 kg/1,000 L 6.25 L	Apply 3 sprays, 3 weeks apart. Apply 1st spray 10 days after 1st adult catch in pheromone traps. Direct these sprays with a hand gun to cover the trunk and scaffold limbs thoroughly. Check preharvest intervals, especially for the 2nd spray, and do not apply if the fruit is to be harvested during this period.

TABLE 10–10. Days to harvest intervals for products used on sour cherries

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the number of days between the last spray and first harvest.

Product Name	Preharvest interval (days)
Bravo 500	40
Supra Captan 80 WDG	5-sour; 2-sweet
Cabrio EG	10
Diazinon 50 W	10
Elevate 50 WDG	1
Endosulfan 50 W	15
Equal 65 WP	7
Ferbam 70 WDG	4
Funginex 190 EC	Do not apply after bloom
Guthion Solupak	15
Imidan 50 WP	7
Indar 75 WSP	1
Kelthane 50 W	7
Kumulus DF	1
Lance WDG	1
Maestro 80 DF	5-sour; 2-sweet
Nova 40 W	1
Rovral	1
Sevin XLR Plus	2
Sniper	15
Thiodan 50 WP	15
Thionex 50 WP	15
Topas 250E	3
Zolone Flo	14

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

NOTES ON SOUR CHERRY DISEASES

TABLE 10-11. Cherry leaf spot

Approximate number of hours of wetting required for conidial infection by the leaf spot fungus at different air temperatures[1]

	WETTING PERIOD [hr]		
Average Temp. (°C)	Light Infection [2]	Moderate Infection [2]	Heavy Infection[2]
27	25	39	—
25	14	24	36
23	8	17	26
21	6	13	21
17–20	5	12	19
16	6	13	20
13	10	17	24
10	19	27	35
8	26	36	48

[1] Adapted from Eisensmith and Jones, 1981.

[2] The infection period starts when rain begins.

GROWTH REGULATORS FOR SOUR CHERRIES

Ethephon to Promote Fruit Loosening of Sour Cherries

Ethephon (Ethrel) can be used in sour cherry orchards to promote fruit loosening, uniform maturity and to facilitate mechanical harvesting.

The effectiveness of Ethrel treatment depends on several factors, particularly ambient temperature and tree vigour. The response time of the tree to Ethrel application increases with higher temperatures and decreases at lower temperatures. For this reason, apply Ethrel only in the temperature range of 18°C–30°C. Remember that hot weather shortens the time needed for response.

- Tree vigour also affects the effectiveness of Ethrel treatment. Do not spray with Ethrel trees that have low vigour or are severely stressed by drought, disease or winter injury indicated by gumming on the trunk and scaffold limbs. Treat only trees that are vigorous and in good health.
- Apply ethephon at a rate of 2.75 L per hectare (applied in approx. 2,400 L water per hectare), 7–14 days prior to anticipated harvest. Do not apply any earlier than 14 days prior to anticipated harvest. This rate provides an adequate response to enhance fruit loosening to facilitate mechanical harvesting. Consult the product manufacturer for further information.

Cherry Yellows Virus and Use of Gibberellic Acid

To moderate early production, apply gibberellic acid (GA) at 15 ppm in the 4th year. This allows flowering in year 5 at a reasonable level rather than allowing heavy bloom and production that may significantly reduce growth in future years.

For mature Montmorency sour cherry trees infected with yellows virus, apply GA annually. This helps maintain and extend high fruiting capacity, and reduces occurrence of blind nodes by stimulating lateral shoots and spurs.

- Apply about 3 weeks after full bloom, from shuck fall to 2 weeks after shuck fall. Use concentrations of 10–20 ppm, 15 ppm most commonly used.
- Use lower rates on more vigorous trees. For specific application instructions, including temperature and humidity, consult the product label.

SWEET CHERRY CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 10–12. *Days to harvest intervals for products used on sweet cherries*, on page 193.

Diseases and Insects	Materials	Amount/ha	Comments
Bloom			
	DO NOT APPLY INSECTICIDES WHILE CHERRY TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.		
Brown rot (stem rot and blossom blight stages)	• [5]Topas 250E • Nova 40 W • [2]Rovral • [4]Bravo 500 • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Funginex 190 EC • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 340 g 1.75 kg 7.00 L 4.50 kg 4.50 kg 2.50 L 1.70 kg 370 g 140 g	Blossom blight is favoured by wet, warm (above 16°C) weather, especially when large numbers of mummies are present in the trees. Apply 1st spray just before blossoms open, followed by 2 additional sprays during the bloom period if weather remains favourable for blight. Do not use Captan, Maestro or Bravo within 14 days of an application of Superior Oil. To avoid resistance, do not apply Topas, Nova, Rovral, Elevate, Indar or Lance more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Nova and Topas are absorbed by flower parts, making these materials more rainfast than other protectant fungicides. See note on *Brown rot control* on page 177. Do not apply Bravo after shuck to avoid fruit injury.
Petal fall			
Black cherry aphid	• Diazinon 50 W • Thiodan 50 WP or Endosulfan 50 W • [3]Zolone Flo	3.00 kg 4.50 kg 4.50 kg 2.00 L	A temperature of at least 21°C, thorough coverage and a calm day are needed for effective aphid control. Usually 1–2 sprays are required. Make no more than 3 applications of Zolone/season.
Shuck fall			
Plum curculio	• [9]Guthion Solupak or [9]Sniper 50 W • [3]Zolone Flo	see label see label 2.00 L	Spray when most of the shucks are off and plum curculio activity is observed, usually when temperatures are above 16°C. Zolone also helps control aphids. Make no more than 3 applications of Zolone/season.
Brown rot	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 1.75 kg 4.50 kg 4.50 kg 1.70 kg 370 g 140 g	Captan and Maestro may cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. To avoid resistance, do not apply Topas, Nova, Rovral, Elevate, Indar or Lance more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44.
First cover (12 days after shuck fall)			
Plum curculio	Use one of the insecticides listed under **Shuck fall.**		Zolone helps control aphids but is only fair against plum curculio. Monitor 7 days after **Shuck fall** insecticide for new plum curculio damage. Apply insecticide if new crescent-shaped cuts are found.
Brown rot	Use one of the fungicides listed under **Shuck fall**.		
Second cover (12 days after first cover)			
Cherry fruit fly Plum curculio	• [9]Guthion Solupak or [9]Sniper • Diazinon 50 W • [3]Zolone Flo	see label see label 3.00 kg 2.00 L	On early varieties, check the pre-harvest interval. Spray when early varieties are beginning to colour. Diazinon does not adequately control curculio. Zolone provides 12–14 days protection against cherry fruit fly while Diazinon provides 10 days. Make no more than 3 applications of Zolone /season.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Powdery mildew	• [9]Cabrio EG	670 g	Powdery mildew is not a common problem on sweet cherries. Only required on susceptible varieties.
Brown rot	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 1.75 kg 4.50 kg 4.50 kg 1.70 kg 370 g 140 g	Captan and Maestro may cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. To avoid resistance, do not apply Topas, Nova, Rovral, Elevate, Indar or Lance more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.
Third cover			
Cherry fruit fly	• Sevin XLR Plus • [3]Zolone Flo • Diazinon 50 W	6.25 L 2.75 L 3.00 kg	Sevin XLR Plus provides 5–7 days protection. Make no more than 3 applications of Zolone /season. Check preharvest interval before spraying early maturing cherries.
Brown rot	Use one of the fungicides listed under **Second cover**.		
Prepick			
Brown rot	• [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	1.75 kg 4.50 kg 4.50 kg 1.70 kg 370 g 140 g	Consult product labels for pre-harvest intervals. Captan and Maestro may cause leaf injury to Schmidt and Emperor Francis varieties in postbloom sprays. To avoid resistance, do not apply Topas, Nova, Rovral, Elevate, Indar, or Lance more than 2 times for each product/season. Alternate between fungicide families and do not use the same product in consecutive sprays. See *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44.
Postharvest			
Leaf spot	• Equal 65 WP • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Ferbam 76 WDG	2.25 kg 4.50 kg 4.50 kg see label	Only necessary where leaf spot is a problem or where sweet cherries are beside sour cherries. Captan and Maestro may cause leaf injury to the Schmidt and Emperor Francis varieties in postbloom sprays.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 10–12. Days to harvest intervals for products used on sweet cherries

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the minimum number of days between the last spray and first harvest.

Product Name	Preharvest interval (days)
Bravo 500	40
Cabrio EG	10
Supra Captan 80 WDG	5-sour 2-sweet
Diazinon 50 W	10
Elevate 50 WDG	1
Endosulfan 50 W	15
Equal 65 WP	7
Ferbam 76 WDG	4
Funginex 190 EC	Do not use after bloom
Guthion Solupak	15
Indar 75 WSP	1
Lance WDG	1
Maestro 80 DF	5-sour 2-sweet
Rovral	1
Sevin XLR Plus	2
Sniper	15
Thiodan 50 WP	15
Topas 250E	3
Nova 40 W	1
Zolone Flo	14

See *Notes on Stone Fruit Diseases* on page 177.
See *Notes on Insects and Mites* on page 180.

GROWTH REGULATORS FOR SWEET CHERRIES

To Delay Ripening and Improve Fruit Quality of Sweet Cherries

Research in British Columbia shows that Activol® (contains gibberellic acid) delays fruit ripening 4–5 days, thus lengthening the picking period and delaying the susceptibility to rain cracking. The treatment also increases fruit size, firmness and resistance to postharvest disorders.

- Dissolve 20 ACTIVOL® tablets in 1,000 L of water (20 ppm) and apply as a foliar spray to run off 21 days before normal harvest. The fruit should be at the straw coloured stage.
- Harvest when fruits are at the desired shade of red.
- Do not harvest within 21 days after spraying.

Gibberellic acid treatments are currently being investigated for their potential in Ontario.

PEACH CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 10–13, *Days-to-harvest intervals for products used on peaches*, on page 197.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant (in March or early April before buds swell)			
Leaf curl	• Ferbam 76 WDG • [4]Bravo 500	see label 7.00 L	Delay may result in poor control of leaf curl. Do not apply Bravo 500 within 10 days of an oil application, because it will burn flower and leaf tissue. If mixing Ferbam with oil, follow mixing directions on the Superior "70" Oil label carefully, or poor leaf curl control will result.
(Leaf curl spray is not needed in spring if a spray was applied last fall)			
San Jose scale	• Superior "70" Oil	20 L/1,000 L water	Apply oil routinely every 3rd year. If scale is a serious or continuing problem, apply oil for at least 2 consecutive years.
Prebloom (half-inch green to first pink)			
European red mite	• Superior "70" Oil	20 L/1,000 L water	Preferred time to use oil for red mite control if overwintering populations are high. Red mite populations are more likely to be high if pyrethroid sprays were used the previous year for oriental fruit moth and tarnished plant bug control.
Oriental fruit moth	• Isomate M100 • Isomate Rosso	250 dispensers/ha 500 dispensers/ha	Pheromone mating disruption products are not insecticides, and will not control other pests that may be present. Initial OFM population must be low. Apply to square or rectangular orchard blocks at least 4 ha in size. These products must be applied before moth flight begins. For more information on mating disruption refer to *Oriental fruit moth* on page 181 and OMAF Factsheet, *Mating Disruption for Management of Insect Pests*, Order No. 03-079. Make a 2nd application of Isomate M100 75–80 days after initial application. Isomate Rosso should provide control for up to 120 days. Use both an insecticide and mating disruption for managing 1st generation OFM (see **Shuck split**).
Pink through bloom			
Blossom blight stage of brown rot	• [5]Topas 250E • Nova 40 W • [4]Bravo 500 • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Funginex 190 EC • [2]Rovral • [5]Vangard 75 WG • Microscopic Sulphur • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 340 g 7.00 L 4.50 kg 4.50 kg 2.50 L 1.50 kg 370 g 19.50 kg 1.70 kg 370 g 140 g	Spray when 1st blossoms are opening (late pink). Repeat every 4–5 days if weather is wet. To avoid resistance, alternate between fungicide families. Do not use Nova, Topas, Rovral, Elevate, Lance, Indar, Funginex or Vangard more than 2 times for each product/season and never in consecutive sprays. For more information on resistance management see *Brown rot control* on page 177. Using sulphur may encourage mite build-up. Do not apply Bravo, Captan or Maestro within 10 days of an oil application, because this causes burning of flower and leaf tissue.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Petal fall and shuck spray			
Green peach aphid	• [3]Pirimor 50DF	560 g	Restrict the application to no later than **Shuck fall.** Observe the days-to-harvest interval. Thresholds for application are 30% of terminals infested or 20 colonies/tree for peaches and 10% of terminals infested or 5–10 colonies/tree for nectarines. (See *Notes on Insects and Mites* on page 180.)
First generation oriental fruit moth spray: Shuck split			
Oriental fruit moth	• [6] Lorsban 50 W • [9]Guthion Solupak or [9] Sniper • Imidan 50 WP	3.50 kg see label see label 3.75 kg	Widespread resistance has developed in most areas of Ontario to the organophosphate insecticides such as Guthion and the carbamates including Sevin. Resistance to pyrethroids is also developing at low levels. Use Lorsban for the control of first generation and pyrethroids for generations 2–4 to provide rotation of insecticide families and to avoid rapid selection of resistance to the pyrethroid insecticides. Do not use pyrethroids for 1st generation control of OFM.
Plum curculio	• [9]Guthion Solupak or [9]Sniper	see label see label	Plum curculio is a sporadic pest of peaches and nectarines. Scout edges of orchards near woodlots and wild hosts in spring. Check small fruit for crescent-shaped egg laying scars. If damage is present, it often occurs only on the border of the orchard, and a border spray of 4–6 rows may provide sufficient control. Check developing fruit for new damage 7–10 days later.
Brown rot	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Microscopic Sulphur • [5]Vangard 75 WG • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 1.50 kg 4.50 kg 4.50 kg 19.50 kg 740 g 1.70 kg 370 g 140 g	Alternate between fungicide families. Do not use Rovral, Topas, Elevate, Lance, Indar or Vangard more than 2 times for each product/season and never in consecutive sprays. For more information on resistance management see *Brown rot control* on page 177. Apply another fungicide in 7 days if wet weather persists.
European red mite	• Apollo SC • Kelthane 50 W	300 mL 3.25 kg	If oil was applied in the spring, a miticide is likely not necessary at this time. Apollo is most effective on eggs and newly hatched nymphs. Apply when leaf tissue is present, mites are mostly in the 1st summer generation egg stage and before there are 3 active mites/leaf. Use sufficient water volumes to obtain good coverage, but not less than 475 L/ha. Apply up to 14 days after petal fall. Make no more than 1 application/season to prevent rapid development of mite resistance. Kelthane is most effective on mite nymphs. Check leaves and apply if 5–7 active mites/leaf are present. Kelthane is a slow-acting material, so wait 7–10 days after use to evaluate results. Repeated use of Kelthane has led to red mite resistance.

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Lesser peachtree borer Peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4 EC • Sevin XLR Plus	1.50 kg/1,000 L 1.50 kg/1,000 L 1.75 L/1,000 L 6.25 L	Peachtree borers are sporadic pests. In areas with high borer populations, follow this spray regime. Use pheromone traps to monitor adult activity and begin sprays at 1st flight. Make 3 applications at 5–10 day intervals. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly; do not spray fruit. Check the days-to-harvest interval. Do not apply 2nd Thiodan spray to varieties in the Harrow Diamond and Garnet Beauty season. On these varieties use Sevin XLR Plus. Do not use 3rd Thiodan spray on varieties in the Sunhaven, Redhaven, Veecling and Vivid season. On these varieties use Sevin XLR Plus.
Special sprays (early green fruit stage to pit hardening)			
Tarnished plant bug	• Cymbush 250 EC • [3]Matador 120 EC • Thiodan 50 WP or Endosulfan 50 W • [9]Guthion Solupak or [9]Sniper	280 mL 104 mL 4.50 kg 4.50 kg see label see label	General timing is mid-June if 2% or more fruit damage is observed. Where plant bug pressure is high and significant new damage is detected, repeat spray in 5–7 days. Plant bug pressure is lower in orchards with managed sod. Other cultural techniques can reduce damage from this pest (see *Tarnished plant bug* on page 183).
Second generation oriental fruit moth spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Pounce • [3]Matador 120 EC • [9]Guthion Solupak or [9]Sniper • Imidan 50 WP	280 mL 200 mL 275 mL 104 mL see label see label 3.75 kg	Spray all varieties. This generation may require 2 insecticide sprays applied about 14 days apart. Resistance has developed in most areas of Ontario to the organophosphate insecticides such as Guthion, and carbamates including Sevin. Resistance to pyrethroids is also developing at low levels. Where resistance is not a problem, Imidan or Guthion may still provide satisfactory control.
Brown rot (early varieties only Harrow Diamond through Sunhaven)	• [5]Topas 250E • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Rovral • Microscopic sulphur • [5]Vangard 75 WG • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 4.50 kg 4.50 kg 1.50 kg 19.5 kg 740 g 1.70 kg 370 g 140 g	Use of sulphur may induce mite problems. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. For more information on resistance management see *Brown rot control* on page 177.
Special sprays (when monitoring indicates the need)			
European red mite Two-spotted spider mite	• [3]Pyramite • Kelthane 50 W • Carzol SP	300 g 3.25 kg 1.10 kg	Apply this spray around the **Second oriental fruit moth spray** (early July). On cultivars Harbrite and later, examine for mites again 3 weeks before harvest. Take action if the threshold of 5–10 active mites/leaf is reached in July. Monitor carefully because populations can build rapidly. Check product labels for preharvest intervals. Pyramite is the preferred material at this timing. Pyramite is most effective when applied to mite nymphs. Use 600 g/ha for two-spotted spider mites. Pyramite has a 14 days-to-harvest interval. Make no more than 1 application/season. Miticides are best used alone. Use a minimum water volume of 1,000 L/ha for effective control.
Third generation oriental fruit moth spray (late varieties)			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Pounce • Imidan 50 WP	280 mL 200 mL 275 mL 3.75 kg	Usually for all varieties from Vivid season and later.

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[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Brown rot	• [5]Topas 250E • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Rovral • Microscopic sulphur • [5]Vangard 75 WG • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 4.50 kg 4.50 kg 1.50 kg 19.5 kg 740 g 1.70 kg 370 g 140 g	Use of sulphur may induce mite problems. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest. For more information on resistance management see *Brown rot control* on page 177.
Prepick spray			
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Pounce • Imidan 50 WP	280 mL 200 mL 275 mL 3.75 kg	Spray each variety 7–10 days before 1st harvest when first colour shows. See comments on organophosphate resistance under **First oriental fruit moth spray**.
Brown rot	• [5]Topas 250E • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Rovral • Microscopic sulphur • [5]Vangard 75 WG • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 4.50 kg 4.50 kg 1.50 kg 19.5 kg 740 g 1.70 kg 370 g 140 g	Apply with OFM sprays 7–10 days before harvest. Use of sulphur may induce mite problems. For more information on resistance management see *Brown rot control* on page 177.
Rhizopus rot	• Botran 75 W	See label	
Special spray			
Brown rot	• [2]Rovral • Micrscopic Sulphur • [5]Vangard 75 WG • [1]Elevate 50 WDG • [1]Lance WDG • [2]Indar 75 WSP	1.50 kg 19.5 kg 740 g 1.70 kg 370 g 140 g	This spray is only necessary under rainy and humid conditions just prior to harvest (within 3 days of picking). This is the preferred time to use Rovral. Use of sulphur may induce mite problems. For more information on resistance management see *Brown rot control* on page 177.
Fall spray (preferred time to spray for leaf curl)			
Leaf curl	• Ferbam 76 WDG • [4]Bravo 500	see label 7.00 L	Apply any time after leaves are off in fall or winter when temperature in shade is above freezing and conditions favour rapid drying.

TABLE 10–13. Days-to-harvest intervals for products used on peaches

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the minimum number of days between the last spray and first harvest.

Product Name	Preharvest interval (days)
Apollo SC	Apply no later than 14 days after petal fall
Botran 75 W	10
Bravo 500	60
Supra Captan 80 WDG	2
Carzol SP	21
Cymbush 250 EC	7
Decis 5 EC	1
Elevate 50 WDG	1

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[5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.*
[8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*
FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 10–13. Days-to-harvest intervals for products used on peaches (cont'd)

Product Name	Preharvest interval (days)
Endosulfan 50 W	15
Ferbam 76 WDG	21
Funginex 190 EC	Do not apply after bloom
Guthion Solupak	21
Imidan 50 WP	1
Indar 75 WSP	1
Kelthane 50 W	14
Lance WDG	1
Lorsban 50 W	21
Maestro 80DF	2
Matador 120 EC	7
Microscopic Sulphur	1
Nova 40 W	1
Pirimor 50 DF	60
Pounce	7
Pyramite	14
Rovral	1
Sevin XLR Plus	1
Sniper	21
Superior "70" Oil	Apply prebloom
Thiodan 4 EC	15
Thiodan 50 WP	15
Topas 250E	3
Vangard 75 WG	2

Guidelines for Protecting Young Non-Bearing Peach Plantings

The following is designed to offer limited protection when needed for newly planted trees. See the label for rates to apply.

Diseases and Insects	Materials	Comments
Preplant		
Nematodes	Peaches are very susceptible to nematodes. See *Nematodes* on page 48.	
Lesser peachtree borer Peachtree borer	• Thiodan 4 EC	If trees were not treated at the nursery, dip the roots and crown. The dip provides control for peachtree borer in the 1st year. Use chemical resistant gloves to avoid exposing skin to insecticide. Dispose of excess material with extreme care. Thiodan is extremely toxic to fish and wildlife.
First oriental fruit moth and borer spray		
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • [9]Guthion Solupak or [9]Sniper 50 W	Resistance has developed in Niagara to organophosphate insecticides such as Guthion, and the carbamates including Sevin and Lannate. Where resistance is not a problem, Imidan or Guthion may still provide satisfactory protection.
Lesser peachtree borer	• Thiodan 4 EC or Thiodan 50 WP or Endosulfan 50 W	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each oriental fruit moth spray in the 2nd year. Borers invade trunks from the ground level up and may complicate canker infections. The problem appears to be more severe in southwestern Ontario. Insecticides for OFM help control borer if trunk coverage is thorough.

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[5] *Minimum period for re-entry is 72 hr.* [6] *Minimum period for re-entry is 4 days.* [7] *Minimum period for re-entry is 5 days.*
[8] *Minimum period for re-entry is 7 days.* [9] *Minimum period for re-entry is greater than 7 days. See label.*

Diseases and Insects	Materials	Comments
Green peach aphid	• [3]Pirimor 50 DF	Green peach aphid may colonize and stunt new growth. Begin monitoring mid to late May for this pest. Apply controls when 30% of terminals are infested.
Second oriental fruit moth and borer spray		
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • [9]Guthion Solupak or [9]Sniper 50 W	See comments on organophosphate resistance under **First oriental fruit moth spray**.
Lesser peachtree borer	• Thiodan 4 EC or Thiodan 50 WP or Endosulfan 50 W	For borer control, aim a nozzle toward the trunk. Apply 5–10 days after each oriental fruit moth spray in the 2nd year.
Green peach aphid	• [3]Pirimor 50 DF	
Third oriental fruit moth and borer spray		
Oriental fruit moth	• Cymbush 250 EC • Decis 5 EC • Imidan 50 WP • [9]Guthion Solupak or [9]Sniper 50 W	See comments on organophosphate resistance under **First oriental fruit moth spray**.
Lesser peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4 EC	For borer control, aim a nozzle toward the trunk. Apply 5 - 10 days after each oriental fruit moth spray in the 2nd year.
Mites	Mites are usually not a problem on non-bearing trees. Trees can tolerate about 30 pest mites/leaf. See also *Notes on Insects and Mites* on page 180.	

NOTES ON PEACH PESTS

Peach canker

Peach canker, also called perennial canker, is caused by 2 related fungi of the genus *Leucostoma*. The first noticeable symptom is an amber coloured gum, produced at the site of infection. Infections on small twigs appear as sunken discoloured areas. Large, blackened, calloused cankers on trunks and main scaffold branches are the most obvious symptoms of the disease. Most peach trees will eventually become infected with the fungus, which will reduce yields by weakening or killing scaffolds and eventually the tree. Use the following practices to limit or delay the development of peach canker.

When pruning

- Avoid cutting into the collar area of the branch where it meets main branches or the trunk of the tree. When the collar area is injured or cut, the healing process is delayed or impaired, because wound-healing periderm tissues are located primarily in the collar region.
- Perform surgery on younger trees during June and early July. Remove all diseased bark around the canker and about 3–5 cm of healthy tissue from around the sides and ends, respectively. The resulting wound, when finished, should have a smooth margin and be slightly rounded above and below to favour rapid wound closure.
- Leave surgery sites uncovered without wound dressing. Some pruning paints seal in moisture, providing an ideal environment for fungal infection and prevent healing.

At planting time and first year

- Plant good nursery stock free of infection. Use Thiodan dip for borer control. See *Guidelines for Protecting Young Non-Bearing Peach Plantings* on page 198.
- Prune new trees shortly after planting during warm, dry days.

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[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

- Remove all poor angles and weak side branches.
- In mid-June, remove all dead wood and poorly angled new shoots.
- Apply sprays for oriental fruit moth, plant bugs, peachtree and lesser peachtree borer.
- Sow a cover crop (early July).
- Protect trees from rabbits and mice.
- Avoid any contact with herbicides on the young bark tissue.
- Apply a fall paint to protect for southwest injury. See *Control of Southwest Injury on Fruit Trees* on page 54.

Second and following years

- Apply nitrogen fertilizers early (March, April) to bearing trees or consider split applications for nitrogen in spring and early summer.
- Avoid late applications of manure.
- Prune during warm, dry days at bloom time or just shortly after.
- Remove all dead wood and poorly angled branches.
- In June, remove dead wood and lightly thin out new growth.
- Apply sprays for oriental fruit moth, peachtree borers, plant bugs and brown rot.
- Sow a cover crop (early June).
- Remove diseased fruit at harvest or immediately after harvest before infected fruit injures the wood tissue.
- Protect trees from rabbits and mice.
- Reapply a fall paint to protect against southwest injury until the tree is 5 years old.

Southwest injury and rodent control

Use latex paint-based repellent. Paint the whole trunk, plus the base of major scaffolds. *Control of Southwest Injury on Fruit Trees* on page 54 for details.

See *Notes on Stone Fruit Diseases* on page 177.
See *Notes on Insects and Mites* on page 180.

THINNING PEACHES

Peach thinning is an essential orchard management practice and is necessary to obtain good-sized, quality fruit.

Most peach cultivars have the potential for over-cropping, which results in limb breakage, reduced fruit size and quality, loss of tree vigour, shortened orchard life and increased pest management problems. Optimum fruit load depends on cultivar, tree vigour, orchard management (tree spacing, irrigation, pruning), tree age, and tree health (free from winter injury and peach canker).

Often fruit spacing receives more attention than fruit load. Orchardists tend to think of spacing the fruit 15–20 cm apart. Distance between fruit is not too critical as long as clusters are broken up and fruit is separated. Tree crop load (kilogram per tree or number of fruit per tree) is a more important consideration. As an example, a yield of 18–27 tonnes/ha (8–12 t/acre) in an orchard with a tree density of 490 trees/ha (200 trees/acre) requires about 200–300 fruit/tree, assuming an average fruit size of 4–7 fruit/kg (2–3 fruit/lb.). With current emphasis on increased fruit size for better marketability and trends towards higher tree densities, fruit loads of 175–200 fruit/tree may be more ideal, at least for cultivars that normally produce large fruit.

Some factors that must be taken into consideration are:

Timing — Start thinning near the end of June drop (about mid-June) when it can be determined which fruits will abort and fall on their own. Thinning at early fruit development or even blossom time is more beneficial than late thinning. However, it is difficult to get a true assessment of crop load before June drop occurs. Thin early-ripening cultivars first in order to obtain proper fruit size. In some years, a follow-up hand thinning may be necessary.

Pruning — An essential part of the fruit-thinning procedure. A considerable amount of the fruit-bearing surface is selectively removed, which also removes some of the excess crop. Normal fruit thinning must follow to avoid over-cropping.

Cultivars — Cultivar selection over the years has tended towards larger fruit. Earlier ripening cultivars frequently bear a fairly high percentage of fruit having split pits. Growers often lightly-thin once, early, to remove some crop load, then a second time to selectively remove split-pit fruit. Recently introduced, Harrow Diamond is the earliest commercial-ripening cultivar with few split-pit fruit. This cultivar must be well thinned to obtain suitable size. There is little likelihood of over-thinning early cultivars when the set is heavy. Heavy-setting, hard-to-size cultivars such as Redhaven require heavier thinning than easier-to-size types like Vivid and Loring. As a rule of thumb, however, late maturing cultivars with a good, uniform set are thinned 10–13 cm apart in order to produce good-sized fruit. Cultivars are different and are thinned according to their individual requirements.

Irrigation — In many commercial farms irrigation is used to enhance fruit size, especially during long periods of dry conditions. Start irrigating early in the season and continue a regular schedule based on rainfall. Orchards without irrigation may, in some years, need a second thinning during July to attain marketable fruit size.

Thinning methods — Thinning is most commonly accomplished by hand with manual labour. Physical aids such as a child's plastic bat, a rubber hose mounted on a bamboo pole or broom handle, or a plastic rake manufactured for this purpose are useful to remove large quantities of fruit in a hurry. Initial thinning is often followed up by a "touch-up" thinning to assure that fruit numbers per tree produce good-sized fruit for the cultivar and orchard condition. It is important to ensure that clusters are broken up and fruit separated. If the set is spotty on the tree, more fruit may be left on the heavy-set branches.

Other methods that have been investigated are:

Mechanical trunk shaker — This method of shaking fruit when they are walnut-size is erratic and can result in over-thinning. The negative, long-term effect on the root system has yet to be determined.

Rope thinning of blossoms — Tree training systems have not yet been properly developed to adapt rope thinning. Only the older, standard pruning style using mature trees has been tried with moderate success in growers' orchards. Timing is also a problem because it conflicts with pruning.

Chemical thinning — There are presently no chemicals registered for fruit thinning peaches in Ontario.

Any of the above methods must be supplemented by touch-up hand thinning.

PEAR CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 10-14, *Days to harvest intervals for products used on pears,* on page 205.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant			
Scale insects Pear psylla	• Superior "70" Oil	20 L/1,000 L water	Use 2,000-3,000 L of water/ha. Good coverage is essential. Do not apply full rate of oil more than once/season.
Green tip			
Scab	• Equal 65 WP • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [4]Dikar • [2]Flint 50 WG	3.25 kg 3.75 kg 3.75 kg 6.75 kg 140 g	It is important to start scab control early and repeat the spray if weather remains wet. Do not use Captan or Maestro on d'Anjou pears. When Dikar is used in a full season program at 10-day intervals, it controls pear scab and nymphal stages of pear psylla. It also suppresses European red mite and rust mite populations. It must not be used within 45 days of harvest. Higher water volumes aid in mite suppression.
European red mite Pear psylla	• Superior "70" Oil	20 L/1,000 L water	Best applied at or near **Green tip** for mites. Use 2,000-3,000 L of water/ha. Good coverage is essential. Oil is not effective for rust mite control. Do not apply full rate of oil more than once/season.
Oriental fruit moth	• Isomate M100 • Isomate Rosso	250 dispensers/ha 500 dispensers/ha	Pheromone mating disruption products are not insecticides, and will not control other pests that may be present in the orchard. Initial OFM population must be low. Apply to square or rectangular orchard blocks at least 4 ha. in size. These products must be applied before moth flight begins. For more information on mating disruption refer to *Oriental fruit moth* on page 181 and OMAF Factsheet, *Mating Disruption for Management of Insect Pests,* Order No. 03-079. Make a 2nd application of Isomate M100 75-80 days after initial application. Isomate Rosso provides control for to 120 days. In crops with long field seasons, make a 2nd application. Use both an insecticide and mating disruption for managing 1st generation OFM (see **Petal fall**).
Prebloom (as blossoms show white at tips)			
Scab	Use one of the materials listed for scab control under **Green tip**. Repeat spray if weather remains wet.		
Rust mite European red mite	• Carzol SP • Kelthane 50 W	1.10 kg 3.25 kg	Carzol is harsh on beneficial mites and honey bees. Some resistant mites may be present when Kelthane has been used for 4 or more years; an alternative miticide is advisable.
Pear psylla	• [9]Guthion Solupak or [9]Sniper • Thiodan 50 WP or Endosulfan 50 W • [5]Pyramite • [2]Assail 70 WP	see label see label 6.75 kg 6.75 kg 600 g 120 g	To avoid resistance problems, pyrethroids are not recommended at this time. Refer to comments at **First cover.** Guthion also controls green fruitworm. Maximum 2 applications Pyramite/season. Maximum 4 applications Assail/season.
Green fruitworm Obliquebanded leafroller	• Dipel 2X DF or Foray 48BA • Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [2,9]Success 480 SC	1.12 kg 2.80 L 3.75 kg see label see label 182 mL	Dipel and Foray suppress obliquebanded leafroller. B.t. formulations such as Dipel and Foray are most effective when larvae are actively feeding and weather is warm and dry for 3 days after application. 2-3 applications of B.t. may be required to cover the extended emergence of overwintering larvae.

Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Plant bugs	• Thiodan 50 WP • or Endosulfan 50 W	4.50 kg 4.50 kg	Thiodan helps to control psylla.
Bloom			
There are special pollination requirements for pears. See pollination requirements for fruit crops, page 63.			
DO NOT APPLY INSECTICIDES WHILE PEARS ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.			
Fire blight	• [8]Streptomycin 17	600 g/1,000 L	Sprays are most effective when applied dilute (high volumes of water) prior to a wetting period. Use alone for best results. Because Streptomycin 17 is UV light sensitive it is only effective for 2–3 days. If warm wet conditions (above 20°C) prevail, 2–3 sprays during the bloom may be required for fire blight control. To avoid resistance use a maximum of 3 sprays/season. (See Fire blight of pear on page 207).
Petal fall			
Plum curculio	• [9]Guthion Solupak or [9]Sniper	see label see label	
Pear psylla	• Agri-Mek 1.9 EC • [9]Guthion Solupak or [9]Sniper • Thiodan 50 WP or Endosulfan 50 W • [3]Pyramite • [2]Assail 70 WP	1.00 L see label see label 6.75 kg 6.75 kg 600 g 120 g	Do not use Agri-Mek within 14 days of a Captan or Maestro application. Apply Agri-Mek no later than 21 days after petal fall for best results. Apply with 10 L superior oil and a minimum of 1,000 L of water/ha. Apply when majority of population is in the nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. To prevent or delay resistance, do not apply Agri-Mek more than once/season. Ideally, alternate yearly with other insecticides (e.g. Mitac). Agri-Mek will not control plum curculio. Maximum 2 applications Pyramite/season.
Oriental fruit moth	• Decis 5 EC • [2]Assail 70 WP	250 mL 240 g	Begin applications at egg hatch, usually 3–6 days after peak OFM flight as indicated by regional trap catches. Alternate products from different families to prevent the development of resistance. See Table 4–1, *Insecticide and miticide groups based on sites of action* on page 46. Maximum of 4 applications Assail/season.
Rust mite European red mite	Use one of miticides listed in **Prebloom**.		A single miticide applied at **Prebloom** or **Petal fall** is necessary for good mite control. Rust mite must be controlled no later than **Petal fall** to avoid russetted fruit at harvest. Alternate miticides.
Leaf spots Scab	Use one of the fungicides listed for scab at **Green tip**.		If wet weather persists, additional sprays will be needed for scab control before **First cover**. Where there is a problem, spray at **Petal fall** and **First cover**. A dilute spray is necessary for good control.
Special spray (if needed at petal fall)			
Codling moth	• Imidan 50 WP • [9]Guthion Solupak or [9]Sniper • [2]Assail 70 WP	3.75 kg see label see label 170 g	Codling moth might be a problem if pear plantings are located near wild apple, pear and other hosts infested with codling moth. For sites with a history of codling moth damage, apply one of these insecticides. Use codling moth timing as recommended for apple.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
First cover (about June 25)			
Pear psylla	• Mitac WP	2.50 kg	Apply when the majority of the population is in early instar stages. Where plum curculio is a later season problem, use one of the materials recommended at **Petal fall**. Use Mitac only once/year and when populations of psylla are high, e.g., greater than 25 active/sucker. Mitac also controls European red mite. Resistance to pyrethroid insecticides (Decis, Ripcord, Cymbush, Pounce, Matador) is widespread. Apply Agri-Mek no later than 21 days after **Petal fall** for best results. Apply with 10 L Superior Oil and a minimum of 1,000 L of water/ha. Apply when majority of population is in nymphal stage. May cause russetting to d'Anjou and other sensitive varieties. Do not use within 14 days of a Captan or Maestro application. Maximum 1 application Agri-Mek/season. Maximum 2 applications Pyramite/season. Maximum 4 applications Assail/season.
	• Thiodan 50 WP	6.75 kg	
	or Endosulfan 50 W	6.75 kg	
	• [9]Guthion Solupak	see label	
	or [9]Sniper	see label	
	• Decis 5 EC	350 mL	
	• Ripcord 400 EC	250 mL	
	or Cymbush 250EC	280 mL	
	• Pounce	520 mL	
	• [3]Matador 120 EC	83 mL	
	• Agri-Mek 1.9 EC	1.0 L	
	• [3]Pyramite	600 g	
	• [2]Assail 70 WP	120 g	
Scab	Use one of the fungicides listed under **Green tip**. Reduce rate of Equal to 2.25 kg/ha in cover sprays.		
Obliquebanded leafroller	• Dipel 2X DF	1.12 kg	Resistance to the organophosphates such as Imidan and Guthion is becoming more widespread. All of these products will only suppress leafroller populations.
	or Foray 48BA	2.80 L	
	• [9]Guthion Solupak	see label	
	or [9]Sniper	see label	
	• Imidan 50 WP	3.75 kg	
	• [2, 9]Success 480 SC	182 mL	
Special spray (if needed at first cover)			
Blister mite	• Sevin XLR Plus	6.25 L	
	• Thiodan 50 WP	4.50 kg	
	or Endosulfan 50 W	4.50 kg	
Summer sprays			
Pear psylla	• Mitac WP	2.50 kg	Apply when majority of the population is in early instar stages. Use Mitac only once/season and when populations of psylla are high, e.g., greater than 25 active/sucker. Mitac also controls European red mite. Guthion is the most effective summer insecticide to control codling moth, if it should become a problem. Maximum 2 applications Pyramite/season. Maximum 4 applications Assail/season.
	• [9]Guthion Solupak	see label	
	or [9]Sniper	see label	
	• Thiodan 50 WP	6.75 kg	
	or Endosulfan 50 W	6.75 kg	
	• Decis 5 EC	350 mL	
	• Ripcord 400 EC	250 mL	
	or Cymbush 250 EC	280 mL	
	• Pounce	520 mL	
	• [3]Matador 120 EC	83 mL	
	• [3]Pyramite	600 g	
	• [2]Assail 70 WP	120 g	
Codling moth	• Imidan 50 WP	3.75 kg	Codling moth can be a problem if pear plantings are located near wild apple, pear and other hosts infested with codling moth. Mitac and Agri-Mek in pear psylla programs provide no protection of fruit against codling moth. For sites with a history of codling moth damage, apply one of these insecticides. Use codling moth timing as recommended for apple.
	• [9]Guthion Solupak	see label	
	or [9] Sniper	see label	
Mites	• Kelthane 50 W	3.25 kg	Examine orchards for red mite and rust mite injury about July 15–20 or 10–15 days after using a pyrethroid. Do not apply closer to harvest than the number of days given in Table 10–14, *Days to harvest intervals for products used on pears*, on page 205. Alternate miticides. Carzol is harsh on beneficial mites. Maximum 2 applications Pyramite/season.
	• Carzol SP	1.10 kg	
	• [3]Pyramite	300 g	

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FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
Second cover			
Scab	Use one of the fungicides listed under **Green tip**. Reduce rate of Equal to 2.25 kg/ha in cover sprays. Dikar has a 45 days-to-harvest interval.		
Sooty blotch	• [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Flint 50 WG	3.60 kg 3.75 kg 140 g	Repeat spray for sooty blotch 2 weeks later. Do not use Captan or Maestro on d'Anjou pears.
Special sprays (about mid-Aug. and early Sept.)			
Codling moth	• [9]Guthion Solupak or [9]Sniper • Imidan 50 WP • [2]Assail 70 WP	See label see label 3.75 kg 170 g	Codling moth can infest pear as maturation and ripening begins. Bosc pears can be heavily infested and may require 2 preharvest sprays about 2 weeks apart. For Bosc, Anjou and Bartlett a spray 7–10 days prior to harvest is recommended in orchards adjacent or near peaches.
Oriental fruit moth	• Decis 5 EC • [2]Assail	250 mL 240 g	
Obliquebanded leafroller	• Dipel 2X DF or Foray 48BA • [9]Guthion Solupak or [9]Sniper 50 W • Imidan 50 WP • [2, 9]Success 480 SC	1.12 kg 2.80 L see label see label 3.75 kg 182 mL	
Postharvest treatment			
Blue mould	• Mertect SC	500 mL/ 500 L water	For use in dip tank or drencher. Continuous agitation required. Follow label instructions. Does not control any blue mould (*Penicillium*) or grey mould (*Botrytis*) which is resistant to benzimidazole fungicides (e.g., Benlate).

Guidelines for Protecting Young Non-Bearing Pear Plantings

The following program provides protection when needed for newly planted trees. To improve pest control, remove neglected fruit trees in the area, select of intercrops carefully, (if used) and maintain a clean, weed free environment. To determine the appropriate rate for small trees, see the product label, and refer to OMAF Factsheet *Guide for Spraying Tree Fruits*, Order No. 00-035. Additional products are listed in the calendar for bearing fruits

Diseases and Insects	Materials	Comments
Fire blight	• [8]Streptomycin 17	Avoid excess nitrogen applications. Conduct regular leaf analysis. See *Fire blight of pear* on page 207.
Pear psylla	• Thiodan 50 WP or Endosulfan 50 W	If nymphs are observed, spray when 75% of the petals have fallen in nearby bearing orchards.
Leaf-feeding insects	• Imidan 50 WP	Apply at any time when small caterpillars are feeding.
Pear psylla (summer broods)	• Thiodan 50 WP or Endosulfan 50 W	Target early nymphal stages.
European red mite	• Carzol SP	Check foliage frequently and spray if 7–10 mites/leaf are observed or at 1st sign of leaf bronzing.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS. SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 10–14. Days to harvest intervals for products used on pears

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the minimum number of days between the last spray and first harvest.

Product Name	Preharvest interval (days)
Agri-mek 1.9 EC	28
Assail 70 WP	7
Supra Captan 80 WG	7
Carzol SP	1
Cymbush 250 EC	7
Decis 5 EC	7
Dikar	45
Dipel 2X DF	1
Endosulfan 50 W	15
Equal 65 WP	7
Flint 50 WG	14
Foray 48 BA	1
Guthion Solupak	14
Imidan 50 WP	1
Kelthane 50 W	7
Maestro 80 DF	7
Matador 120 EC	7
Mertect SC	postharvest
Mitac W	14
Pounce	7
Pyramite	25
Ripcord 400 EC	7
Sniper	14
Streptomycin 17	30
Success 480 SC	7
Superior "70" Oil	use prebloom
Thiodan 50 WP	15

NOTES ON PEAR DISEASES

Blue mould and grey mould in stored pears

Under certain conditions rot can develop on pears during storage. Disease organisms are common in and around grading lines, work areas and storages. Fungi causing blue mould (*Penicillium*) and grey mould (*Botrytis*) are spread in air currents and by water.

Infection of pears most commonly occurs after harvest through stem punctures, wounds, skin breaks and heavy bruises. These fungi can be transferred from contaminated bins, water used for dipping or drenching, and grading equipment.

Rot develops faster if the infected pears are delayed going into storage, cooled slowly in storage, stored for a longer period, or held at warm temperatures after removal from storage.

Reducing disease development

- Handle fruit carefully during and after harvest to minimize stem punctures, skin breaks and bruising. This greatly reduces the number of infection sites on the fruit.
- At storage facilities, lift truck operators must move the bins with a minimum of jolting and dropping.
- Refrigerate fruit as quickly as possible. Adequate refrigeration capacity for each storage room is required. Modern refrigeration facilities and controlled atmospheres reduce incidence of fruit rot.
- Remove and dispose of rotted fruit from the premises carefully and frequently. Good sanitation greatly reduces the dispersal and spread of disease organisms within the building.
- Change the water used for dipping or drenching frequently. This reduces the accumulation of fungal spores in the water, greatly reducing the risk of fruit infection.

Fabraea leaf spot

Identification

Fabraea leaf spot, caused by the fungus *Fabraea maculata*, has increased in Ontario pear orchards recently. The disease is particularly severe during warm, wet and humid growing seasons following mild winters and wet springs.

Fruit and leaves are susceptible to infection throughout the growing season. In the spring, reddish-purple pinpoint spots appear on both the lower and upper surface of young leaves. The spots enlarge and become brown and necrotic, sometimes surrounded by a yellow chlorotic halo. Severely infected leaves turn yellow and drop prematurely. Sunken brown lesions may form on fruit and cause it to crack.

Period of activity

The disease overwinters on leaves and in superficial twig cankers. Spores are dislodged and spread by rain splash. Infections occur within 8–12 hours, depending on the length of the leaf wetness period and temperature. Lesions appear 7 days after infection.

Management notes

Disease management is more successful when the primary source of inoculum is eliminated. In small orchards, leaves can be raked or removed from the orchard. For larger plantings, mowing or chopping fallen leaf litter speeds up the decomposition process and reduces inoculum.

There are no fungicides registered for Fabraea leaf spot control. Some fungicides used to control pear scab help suppress this disease.

Fire blight of pear

Fire blight can be a major disease problem for Ontario pear growers. The following practices can help reduce blossom and shoot blight infection. See OMAF Factsheet *Fire Blight of Apple and Pear in Ontario*, Order No. 02-011, for more information on fire blight.

Cultural practices

Avoid applying excessive amounts of nitrogen fertilizer in the spring. Succulent, rapidly growing shoots and suckers are more susceptible to fire blight infection.

- Remove all diseased wood in the dormant season (January or February) when temperatures are below freezing.
- Patrol orchards at least twice per week when blossom and shoot blight symptoms are predicted to occur.
- When the number of strikes is low remove these new infections from the orchard to avoid further spread of the disease.
- Use pruning tools to remove new infections at least 30–45 cm below discoloured wood.
- Disinfect pruning tools by mixing 1 part household bleach in 4 parts water. After use, wash and oil tools to prevent rust. Denatured alcohol (ethanol) is a better disinfectant than the bleach solution and does not rust tools.
- Remove secondary blossoms before they become infected, reducing the potential for fire blight. Secondary blossoms on Bartlett pear probably pose the greatest risk for fire blight infections, but are often too numerous to remove.

Chemical control

In spring, warm temperatures (18°C or greater) and moisture (rain or heavy dew) favour infection of blossoms. When these conditions are predicted, and they persist through the blossom period, protect the blossoms with Streptomycin 17 at 100 ppm (100 ppm = 600 g product/1,000 L water).

- Spray during slow drying conditions. Spray is most effective when applied dilute (high volumes of water) prior to a wetting period. For best results use Streptomycin 17 alone in the tank. Because it is sensitive to ultraviolet light, Streptomycin 17 is effective for only 2–3 days.
- If warm, wet conditions (above 18°C) continue, reapply after 2–3 days to protect newly opened blossoms.
- Two–3 sprays during the bloom period may be necessary to protect blossoms against fire blight infection.
- In non-bearing orchards, copper sprays may be substituted for Streptomycin 17. However, copper sprays are less effective than Streptomycin 17 for controlling fire blight. Mix copper sprays with lime according to label directions. For more information on registered formulations, rates and mixing instructions see *Use of Copper Products on Fruit Crops* on page 54.
- If hail or damaging winds occur during the growing season, apply Streptomycin 17 within 12 hours to prevent serious damage to the fruit and trees. Beyond 24 hours, streptomycin is not effective. Ensure a 30–day to harvest interval on pears.

Predicting fire blight infections

Maryblyt and Cougarblight are computer modelling programs. They are designed to predict fire blight infection by using daily minimum and maximum temperatures, rainfall amounts and wetness and forecasted weather. Advanced warning (1–4 days) of fire blight infection is provided during the critical susceptible growth stages. The most precise prediction for your farm is obtained when you use data from your farm with these programs. Maryblyt is available from Gary Lightner, 293 Tuscawilla Hills, Charles Town, WV 25414, tel: 540-869-8372, e-mail: *gary.lightner@fishersci.com*. Cougarblight is available at *www.ncu.wsu.edu/FB2000F.htm*.

Pear scab

Identification

Pear scab, caused by *Venturia pirina*, has a biology and disease cycle similar to apple scab caused by *Venturia inaequalis*. (See *Apple Scab* on page 97.) The pathogen that causes pear scab does not infect apples and vice versa.

Scab symptoms first appear as velvety black spots on young pear fruit. Severely infected fruit drop prematurely. Infected fruit that remain on the trees are often deformed with brown, scabby lesions. Under optimum environmental conditions, the initial lesions produce spores that cause secondary infection. Pinpoint scab lesions may develop on maturing fruit late in the season or after they are placed in cold storage.

Management notes

Management strategies focus on reducing overwintering inoculum in leaf litter and primary infections during the spring. Once primary infections are controlled, secondary infection is also limited and the disease will not become serious. Cultural practices that promote the rapid decomposition of leaf litter on the orchard floor reduce the number of overwintering spores.

For successful scab control during wet weather, apply fungicides in the spring, beginning at green tip and continuing through bloom, petal fall and first cover.

THINNING PEARS

The major pear cultivars grown in Ontario benefit from fruit thinning. The thinning of fruit is particularly beneficial during seasons of heavy fruit set or inadequate moisture. Bartlett and Bosc can set fruit in clusters of 3–5 fruit per spur.

- If fruit set is excessive, reduce the number of fruit per cluster to 1 or 2. If the set on the tree is not excessive, multiple fruit per cluster will reach a satisfactory size without fruit thinning. To obtain large sized fruit, irrigate after shuck split, during extended dry periods in mid summer and a few weeks before harvest.
- Start thinning near the end of June drop (mid-June) when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.
- Thin pears on dwarfing rootstock in order to obtain a high percentage of marketable fruit and prevent limb breakage.
- De-fruit trees during the first 4 years of establishment. Reduce the crop to 1 fruit per spur, spaced 12–15 cm apart during normal years. The combination of proper fruit thinning and irrigation has the most positive results on pear fruit size.
- Response of pears to chemical agents, under Ontario conditions, is inconsistent between years. Try chemical thinning on a small scale until response with respect to tree vigour, cultivar and fruit size can be evaluated.
- Use either NAA (*naphthaleneacetic acid*) or NAD (*naphthaleneacetamide*) for chemical thinning. Suggested rates are: NAA at a concentration of 15–20 ppm approximately 3–6 days after petal fall, or NAD at 10 ppm, 6–9 days after petal fall, depending on tree vigour and amount of thinning desired. For specific application instructions consult the product label.

PLUM CALENDAR

Read the label and follow all safety precautions. Always consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near-drip point. For resistance management refer to *Pest Resistance to Insecticides, Fungicides, Miticides* on page 44. Check Table 10–15, *Days to harvest intervals for products used on plums,* on page 211.

Diseases and Insects	Materials	Amount/ha	Comments
Green tip (just as buds are bursting)			
European red mite Scale insects	• Superior "70" Oil	20 L / 1,000 L water	Spray on a calm day to improve coverage.
Prebloom (when blossoms show white)			
Brown rot	• [5]Topas 250E • [2]Rovral • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • Microscopic Sulphur • Funginex 190 EC • [5]Vangard 75 WG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 1.50 kg 4.50 kg 4.50 kg 19.50 kg 2.50 L 370 g 370 g 140 g	To help control brown rot, knock off fruit mummies when pruning. Cultivate entire orchard before bloom. To avoid resistance, alternate between fungicides and do not use more than 2 applications of Rovral or Vangard/year. See *Brown rot control* on page 177. Sulphur helps control rust mites on European plums and prunes. Captan or Maestro may cause injury under some circumstances. Injury has occurred on Grand Prize, Early Golden, Shiro, Burbank and Ozark Premier. Make 2–3 applications from early to full bloom. Topas will suppress black knot.
Black knot	• [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Indar 75 WSP	4.50 kg 4.50 kg 140 g	Destroy affected wild and neglected plums near orchard. Cut out and burn all black knots before March. Make the cut 15 cm below the swelling. Collect and burn all prunings with knots. Knots left lying on the ground are a source of spores that start new infections. Inspect all plums in early summer for new knots and those missed. Cut these out and burn them. European plums, prunes and damsons are most susceptible. Apply fungicide sprays to protect the developing shoots between the popcorn stage (prebloom) and 1st cover every 3–5 days in wet weather. Spore release may be delayed in dry springs when rains are delayed until after bloom. Under these conditions extend fungicide coverage to 1st cover.
Consider both European and Japanese plums as self-unfruitful. Mixed plantings and insect pollinators are essential. Honeybees readily work plum blossoms.			
Bloom			
DO NOT APPLY INSECTICIDES WHILE PLUM TREES ARE IN BLOOM. SEE BEE POISONING ON PAGE 64.			
Brown rot (Blossom blight)	Use one of the fungicides listed under **Prebloom**.		
Shuck (when most of the shucks are off)			
Brown rot	• [5]Topas 250E • [2]Rovral • Microscopic Sulphur • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [5]Vangard 75 WG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 1.50 kg 19.50 kg 4.50 kg 4.50 kg 740 g 370 g 140 g	Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances. To avoid resistance, alternate between fungicides and do not use more than 2 applications of Vangard or Rovral/season. See *Brown rot control* on page 177. Topas will suppress black knot.
Black knot	• [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [2]Indar 75 WSP	4.50 kg 4.50 kg 140 g	Captan or Maestro may cause leaf injury and spotting of the fruit on Stanley and Japanese plums under some circumstances.
Plum curculio	• [9]Guthion Solupak or [9]Sniper • Imidan 50 WP	see label see label 3.75 kg	If temperatures are high, spray when the shucks split.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr. [5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days. [8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.

FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

Diseases and Insects	Materials	Amount/ha	Comments
European red mite	• Kelthane 50 W	3.25 kg	If oil was not used at **Green tip**, a spray for mites may be required at this time.
First cover (12 days after Shuck)			
Brown rot Leaf spot Black knot	Use one of the fungicides listed under **Shuck**.		Captan or Maestro may cause leaf injury and spotting on the fruit on Stanley and Japanese plums under some circumstances.
Plum curculio	Use one of the insecticides listed under **Shuck**.		
Summer spray			
European red mite	• Kelthane 50 W	3.25 kg	
Second cover			
Brown rot	• [5]Topas 250E • [2]Rovral • Microscopic Sulphur • [4]Supra Captan 80 WDG or [4]Maestro 80 DF • [5]Vangard 75 WG • [1]Lance WDG • [2]Indar 75 WSP	500 mL 1.50 kg 19.50 kg 4.50 kg 4.50 kg 740 g 370 g 140 g	During wet weather repeat applications between pickings. Check interval to harvest. See Table 10–15, *Days to harvest intervals for products used on plums*, on page 211. Apply no more than 2 applications of Topas in the 3 weeks prior to harvest.
Prepick			
Brown rot	Use one of the fungicides listed under **Second cover**.		
Special sprays			
Aphids	• Thiodan 50 WP or Endosulfan 50 W • Diazinon 50 W	3.25 kg 3.25 kg 3.00 kg	Apply only if aphids are a problem. Very thorough coverage and calm warm conditions are needed for good control.
Apple maggot	• Diazinon 50 W • Imidan 50 WP	3.00 kg 3.75 kg	If apple maggot has been a problem on blue plums and prunes, apply 2 or 3 sprays during July and August.
Peachtree borer Lesser peachtree borer	• Thiodan 50 WP or Endosulfan 50 W or Thiodan 4EC • Sevin XLR Plus	1.5 kg/1,000 L 1.5 kg/1,000 L 1.75 L/1,000 L 6.25 L	Apply 3 sprays, 3 weeks apart. Apply 1st spray 10 days after 1st adult catch in pheromone traps. Direct these sprays with a hand gun to cover trunk and scaffold limbs thoroughly. Check preharvest intervals and do not spray if fruit is to be harvested during this period.

Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

TABLE 10–15. Days to harvest intervals for products used on plums

Use this table as a guide, but refer to product label for specific information. The preharvest interval is the minimum number of days between the last spray and first harvest.

Product Name	Preharvest interval
Supra Captan 80 WDG	2
Diazinon 50 W	10
Endosulfan 50 WP	15
Funginex 190 EC	Do not apply after bloom
Imidan 50 WP	1
Indar 75 WSP	1
Kelthane 50 W	7
Lance WDG	1
Maestro 80 DF	2
Microscopic Sulphur	1
Sevin XLR Plus	2
Sniper	15
Thiodan 4 EC	15
Thiodan 50 WP	15
Topas 250E	3
Vangard 75 WG	2

NOTES ON PLUMS

Heat spot

High temperatures may cause purplish spots on plum and prune fruits that exude clear gum. These spots develop about 5–8 days after the hot spell. Summer cover crops and mulch help to reduce this physiological disease.

To reduce this disorder on prunes, spray with 4 kg of calcium chloride in 1,000 L of water during the period from early July to mid-August. Apply 3 sprays, 10–12 days apart.

THINNING PLUMS

In recent years, the market demand for larger fruit has placed more importance on fruit thinning, pruning and irrigation. Japanese plums require systematic fruit thinning; otherwise fruit size will be small and biennial cropping will ensue. European plums grown for fresh market also require thinning in the years of heavy fruit set. Inadequate fruit thinning results in production of under-sized plums and, at times, fruit ripening on overloaded trees will be delayed. To obtain large-sized fruit, irrigate after shuck split, during extended dry periods in mid summer and a few weeks before harvest.

Start thinning near the end of June drop (early to mid-June) when it can be determined which fruit will abort and fall on their own. Thinning at early fruit development has more benefits than late thinning.

Fruit size thinning is preferred to conventional space thinning. Size thinning selectively removes small, weak, blemished or diseased fruit regardless of spacing of the fruits on the branches. The end result should be proper sizing of the fruit remaining on the tree.

11. Tree Nuts

WALNUT CALENDAR

Consult the product label for suggested water volumes. Otherwise, use enough water to ensure thorough spray coverage. Where the product rate is listed in amount/1,000 L, and if a water volume is not provided on the label, use enough water to wet the foliage to the near drip point. Read the label and follow all safety precautions

Diseases and Insects	Materials	Amount	Comments
Prebloom			
Leafrollers	• Dipel 2X DF	1.12 kg/ha	Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees.
1st pistillate flower			
Walnut blight	• Copper Spray	4.00 kg/1,000 L	Apply in sufficient water to ensure complete coverage.
Summer sprays			
Codling moth Filbert worm Walnut husk fly	• [9]Guthion Solupak	2.25 kg/1,000 L	To time sprays accurately, monitor for these pests using pheromone or sticky traps. Do not apply after husks split. Do not use Guthion in back pack or home garden type sprayers.
Walnut blight	• Copper Spray	4.00 kg/1,000 L	Apply in sufficient water to ensure complete coverage. Apply monthly until husks split, but not after husks split. Do not apply more than 4 times/season. Do not apply within 40 days of harvest.

FILBERT/HAZELNUT CALENDAR

Read the label and follow all safety precautions.

Diseases and Insects	Materials	Amount/ha	Comments
Dormant			
Eastern filbert blight	• Guardsman Copper oxychloride 50	3.00 kg/ha	Apply prior to bud break. Apply in sufficient water volume to ensure thorough coverage.
Prebloom			
Leafrollers	• Dipel 2X DF	1.12 kg/ha	Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees.
Postharvest			
Eastern filbert blight	• Guardsman Copper oxychloride 50	3.00 kg/ha	Apply prior to fall rains and when 75% of leaves have fallen. Apply in sufficient water volume to ensure thorough coverage.

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[1] Minimum period for re-entry is 4 hr. [2] Minimum period for re-entry is 12 hr. [3] Minimum period for re-entry is 24 hr. [4] Minimum period for re-entry is 48 hr.
[5] Minimum period for re-entry is 72 hr. [6] Minimum period for re-entry is 4 days. [7] Minimum period for re-entry is 5 days.
[8] Minimum period for re-entry is 7 days. [9] Minimum period for re-entry is greater than 7 days. See label.
FOR ALL RE-ENTRY PERIODS, SEE PRODUCT LABEL FOR SPECIFIC RE-ENTRY REQUIREMENTS AND PRECAUTIONS.

PECANS AND SWEET CHESTNUTS

Read the label and follow all safety precautions.

Diseases and Insects	Materials	Amount/ha	Comments
Prebloom			
Leafrollers	• Dipel 2X DF	1.12 kg/ha	Apply when small larvae are present. Apply in 600–800 L/ha using an orchard air-blast sprayer. Repeat in 7–10 days or after bloom if populations are large. Although Dipel is not toxic to bees, avoid application during bloom. Use 1.6 kg/ha for large or mature trees.

NOTES ON NUT INSECTS

Butternut curculio

Identification

The adult is a snout beetle or weevil, about $^{1}/_{4}$ in. long, brownish gray in colour, with a broad whitish band across the wing covers. The larvae are plump, legless, with a brown head.

Butternut curculio (*Conotrachelus juglandis*) is an economically significant pest of black walnut, English (Carpathian) walnut, Japanese heartnut walnut and butternut. Both the adults and larvae cause injury to the tree and to the nut crop. The adults feed on nuts, tender twig terminals and leaf petioles; the larvae burrow into the nuts, inside young shoots, leaf petioles and stems. For commercial nut orchards, injury to the flowering shoots in early spring and injury to the developing nuts during the summer usually causes premature abortion and drop. In heavy infestation years, the entire nut crop can be lost due to curculio injury. In forest plantations and orchards, larvae feeding in new stems can kill back new branches to the previous season's growth.

Period of activity

Butternut curculio overwinters as an adult in ground litter under trees or along weedy fencerows. The first eggs are laid in new twig growth in early spring. During summer, eggs are laid in crescent-shaped excavations chewed by the adult female in the nut husk near the blossom end.

Larvae become full grown in 4– 5 weeks and emerge from infested twigs and nuts in late July and August. Mature larvae enter directly into the soil to pupate.

New adults begin to emerge in late summer and may feed on shoots, terminal growth and leaf petioles until frost forces adults into the ground cover to overwinter.

Monitoring

Begin monitoring for curculio activity as new spring shoot growth begins. Watch for signs of brownish to black adults, black feeding scars on new shoots and crescent egg laying scars on the nuts until early August.

Codling moth

Identification

Codling moth (*Laspeyresia pomonella*) is a serious pest in English walnuts and less of a problem in other walnut species, although severe infestations may occur in some years. Moths are small (approx. 9 mm) grey-brown with white lines and dark banding. The larva is pinkish white with a brown head, reaching 10–12 mm at maturity. Mature female moths lay eggs on the surface of foliage, twigs and nuts. When eggs hatch the young larvae crawl to and burrow into nuts at the calyx end, or enter where 2 nuts contact each other. Once inside the nut, larvae bore tunnels and expel frass out the opening on the husk surface. Frass that collects on the surface of the nut husk provides a visual indication of larval infestation.

Period of activity

Early season infestations that occur before the developing nut shells harden, will allow larvae to burrow into the kernel or 'nut meat'. Later infestations that occur after the developing shell has begun to harden, will restrict larval tunneling to the husk and not the inner kernel. Infestation by codling moth can cause premature nut drop and may be severe in some years. Where nuts do not drop prematurely, infested husks can impart off-flavours to the kernel.

Monitoring

Use pheromone traps[1] to detect the earliest emergence of new adults in the spring.

Management Notes

Control sprays on walnuts have similar timing as cover sprays applied on apples for codling moth control.

Husk maggot

Identification

Walnut husk maggot (*Rhagoletis sp.*) is a common pest in Ontario and will infest nut husks of English walnuts, Japanese walnuts and native black walnuts. The adult fly, slightly smaller than a housefly, is light brown in colour. Its wings have a dark cross bar pattern. Husk maggot can be differentiated from other fruit maggot pests by the wing pattern (See Figure 11–1, *Wing patterns of walnut husk fly compared to other common fruit flies*). The larvae are a cream colour and grow to 1 cm in length.

Period of Activity

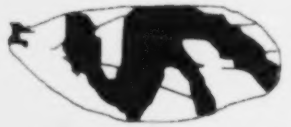
Female adult husk maggot flies lay eggs in the husks of maturing nuts in late summer and early autumn. The eggs hatch and larvae burrow into and feed in the husk, producing black slimy husks that stain the nut shell black. Larvae may be seen crawling on husks as they move from one nut to another. Husk maggot overwinter as pupae in the shallow soil and decaying litter under trees.

Monitoring

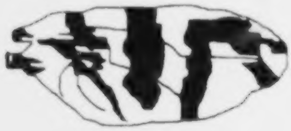
Use yellow sticky board traps[1] to monitor when adult husk maggots emerge prior to egg laying.

Management notes

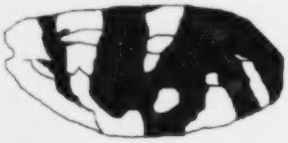
Husks severely infested with maggot at harvest are very difficult to remove from the nut, either by hand or by mechanized de-husking machines. This reduces the crop value. Shell staining makes the nut crop unattractive and undesirable to growers and consumers. Infested husks may impart off-flavours through the shell into the nut kernel, spoiling marketability.



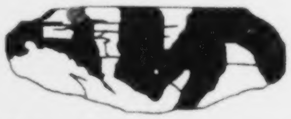
Apple maggot or blueberry maggot fly



Cherry fruit fly



Black cherry fruit fly



Walnut husk fly (eastern)

FIGURE 11–1. Wing patterns of walnut husk fly compared to other common fruit flies

Some control of husk maggot can be achieved by picking up and removing infested walnuts from the orchard floor as soon as possible after they fall from the trees.

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[1] See Appendix F. *Suppliers of Pest Monitoring Equipment and Biological Control Agents*, on page 238.

12. Pesticide Tables

TABLE 12–1. Pesticides used on fruit crops in Ontario

Registration No.	BRAND or TRADE NAME * Common name or active ingredient		Use[1]	Chemical family or activity group	Formulation[2]	Guaranteed % (active unless stated)	Ont. sch.[3]	Man/agent's code[4]
	abamectin	*see* AGRI-MEK 1.9% EC						
	acetamiprid	*see* ASSAIL 70 WP						
24094	ADMIRE 240F	imidacloprid	i	chloronicotine	Fl	240 g/L	5	BCZ
24551	AGRI-MEK 1.9% EC	abamectin	a,i	avermectin	EC	19 g/L	2	ENG
24458	ALIETTE WDG	fosetyl al	f	phosphonate	WDG	80%	2	BCZ
	amitraz	*see* MITAC W						
21035	APOLLO SC	clofentezine	a	tetrazine	SC	500 g/L	2	MKA
27128	ASSAIL 70 WP	acetamiprid	i	chloronicotine	WP	70.35%	3	DUQ
	azinphosmethyl	*see* GUTHION SOLUPAK, SNIPER, GUTHIEN 240 SC						
	bacillus thuringiensis var Kurstaki	*see* DIPEL 2XDF, FORAY 48BA, BIOPROTEC CAF						
8024	BARTLETT WAXED MOUSEBAIT	zinc phosphide	r		pellets	2%	2	BAT
26854	BIOPROTEC CAF	*Bacillus thuringiensis* var Kurstaki	i	Bt microbial	Li	12.7 BIU/L	2	AFG
8772	BOTRAN 75W	dicloran	f	chlorophenyl	WP	75%	3	GOW
	boscalid	see LANCE WDG						
15723	BRAVO 500	chlorothalonil	f	chloronitrile	Fl	500 g/L	3	SYZ
19421	BUSAN 1020	metam sodium	n,f		L	33%	3	BUL
27323	CABRIO EG	pyraclostrobin	f	strobilurin	EG	20%	3	ENG
	captan	*see* Supra CAPTAN 80 WDG, MAESTRO 80 DF						
24613	CAPTAN 80 WDG	captan	f	phthalimide	WDG	80%	3	UAG
	carbaryl	*see* SEVIN XLR PLUS						
	carbofuran	*see* FURADAN 480F						
11144	CARZOL SP	formetanate hydrochloride	a,i	carbamate	SP	92%	5	GOW, BAT
	chlorophacinone	*see* ROZOL, GROUNDFORCE						
	chlorothalonil	*see* BRAVO 500						
	chlorpyrifos	*see* LORSBAN 50W						
	clofentezine	*see* APOLLO SC						
24503	CONFIRM 240F	tebufenizide	i	ecdysone disrupter	Fl	240 g/L	2	DWE

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are captialized.

[1] a — acaracide, miticide; b — bactericide; f — fungicide; h — herbicide; i — insecticide; n — nematicide; r — rodenticide; md — mating disrupter; s — slug bait

[2] symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder; **WSP** — watersoluble packets

[3] See Table 12-3, *Ontario pesticide classification schedules*, on page 223.[4] See Table 12-5, *Pest control product companies*, on page 227.

TABLE 12–1. Pesticides used on fruit crops in Ontario (cont'd)

Registration No.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Chemical family or activity group	Formulation[2]	Guaranteed % (active unless stated)	Ont. sch.[3]	Man/agent's code[4]
9934	COPPER 53W	tri-basic copper sulphate	b, f	inorganic	WP	53%	2	UAG
19146	COPPER SPRAY	copper from copper oxychloride	f	inorganic	WP	50%	3	UAG
25651	CYGON 480-Ag	dimethoate	i	organophosphate	EC	480 g/L	2	CUI
	cyhalothrin lambda	*see* MATADOR 120 EC						
19170	CYMBUSH 250EC	cypermethrin	i	synthetic pyrethroid	EC	250 g/L	2	SYZ
	cypermethrin	*see* CYMBUSH 250 EC, RIPCORD 400 EC						
	cyprodinil	*see* VANGARD 75 WG						
22478	DECIS 5 EC	deltamethrin	i	synthetic pyrethroid	EC	50 g/L	2	BCZ
	deltamethrin	*see* DECIS 5 EC						
	diazinon	*see* DIAZINON 50W, DIAZINON 500E						
11889	DIAZINON 500 E	diazinon	i	organophosphate	E	500 g/L	2	UAG
19576	DIAZINON 50W	diazinon	i	organophosphate	W	50%	2	UAG
	dicloran	*see* BOTRAN 75W						
	dichloropropene	*see* TELONE II						
	dichloropropene + chloropicrin	*see* TELONE C-17						
	dicofol	*see* KELTHANE 50W						
10495	DIKAR	mancozeb + dinocap	a,f	dithiocarbamate	WP	72% + 4.6%	3	DWE
	dimethoate	*see* CYGON 480 AG, LAGON 480E						
26508	DIPEL 2X DF	*Bacillus thuringiensis* var Kurstaki	i	Bt microbial	DF	32 biu/kg	3	VBC
	diphacinone	*see* RAMIK BROWN						
20553	DITHANE DG	mancozeb	f	dithiocarbamate	DG	75%	3	DWE
	dodine	*see* EQUAL 65 WP						
25900	ELEVATE 50 WDG	fenhexamid	f	hydroxyanaline	WDG	50%	2	TOA
	endosulfan	*see* ENDOSULFAN 50 W, THIODAN 4 EC, THIODAN 50 WP, THIONEX 50 WP						
14617	ENDOSULFAN 50W	endosulfan	i	chlorinated cyclodiene	WP	50%	2	UAG
15608	EQUAL 65 WP	dodine	f	guanidine	WP	65%	3	NRA
	fenbuconazole	*see* INDAR WSP						
	fenhexamid	*see* ELEVATE 50 WDG						
	ferbam	*see* FERBAM 76 WDG						
	ferric phosphate	*see* SLUGGO						
20136	FERBAM 76 WG	ferbam	f	dithiocarbamate	WDG	76%	3	UAG
27529	FLINT 50 WG	trifloxystrobin	f	strobilurin	WDG	50%		BCZ

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are captialized.

[1] a — acaracide, miticide; b — bactericide; f — fungicide; h — herbicide; i — insecticide; n — nematicide; r — rodenticide; md — mating disrupter; s — slug bait

[2] symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder; **WSP** — watersoluble packets

[3] See Table 12-3, *Ontario pesticide classification schedules*, on page 223.[4] See Table 12-5, *Pest control product companies*, on page 227.

TABLE 12–1. Pesticides used on fruit crops in Ontario (cont'd)

Registration No.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Chemical family or activity group	Formulation[2]	Guaranteed % (active unless stated)	Ont. sch.[3]	Man/agent's code[4]
	flusilazole	*see* NUSTAR						
15654	FOLPAN 50 WP	folpet	f	phthalimide	WP	50%	3	UAG, MKA
	folpet	*see* FOLPAN 50 WP						
24978	FORAY 48BA	*Bacillus thuringiensis* var Kurstaki	i	Bt microbial	Li	12.7 biu/L	3	VBC
	formetanate hydrochloride	*see* CARZOL SP						
	fosetyl al	*see* ALIETTE WDG						
14701	FUNGINEX 190 EC	triforine	f	piperazine	EC	195 g/L	6	BAZ
10828	FURADAN 480F	carbofuran	i	carbamate	Fl	480 g/L	5	BCZ
13245	GUARDSMAN COPPER OXYCHLORIDE 50	copper from copper oxychloride	f	inorganic	WP	50%	2	VAR
26842	GAVEL 75 DF	zoxamide/mancozeb	f	benzamide + dithiocarbamate	DF	8.3% + 66.7%	3	DWE
8106	GUTHION 240 SC	azinphosmethyl	i	organophosphate	SC	240 g/L	5	BCZ
21374	GUTHION SOLUPAK	azinphosmethyl	i	organophosphate	WSP	50%	5	BCZ
20239	GROUNDFORCE	chlorophacinone	r		pellets	0.005%	6	LPH, UAG
27294	INDAR 75 WSP	fenbuconazole	f	DMI-triazole	WSP	75%	5	DWE
	imidacloprid	*see* ADMIRE 240F						
23006	IMIDAN	phosmet	i	organophosphate	WSP	50%	3	GOW
	iprodione	*see* ROVRAL						
26981	ISOMATE M 100	Pheromone, oriental fruit moth	md	pheromone	DIS	95.2%	3	PBC
27339	ISOMATE M ROSSO	Pheromone, oriental fruit moth	md	pheromone	DIS	95.2%		PBC
27525	ISOMATE GBM PLUS	Pheromone, grape berry moth	md	pheromone	DIS	91.1%		PBC
25147	ISOMATE - GBM	pheromone, grape berry moth	md	pheromone	DIS	83.2%	3	PBC, BAT
24707	KELTHANE 50W	dicofol	a	diphenylethane	WP	50%	2	DWE
	kresoxim-methyl	*see* SOVRAN						
18836	KUMULUS DF	sulphur	f	inorganic	DF	80%	6	BAZ, ENG
9382	LAGON 480 E	dimethoate	i	organophosphate	EC	480 g/L	2	UAG
27495	LANCE WDG	boscalid	f	anilide	WDG	70%	5	BAZ
10868	LANNATE	methomyl	i	carbamate	WSP	90%	5	DUQ
16465	LIME SULPHUR	sulphide sulphur	f	inorganic	Sn	22%	3	UAG
20944	LORSBAN 50W	chlorpyrifos	i	organophosphate	WP	50%	2	DWE
26408	MAESTRO 80 DF	captan	f	phthalimide	DF	80%	2	TOA

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[1] a — acaracide, miticide; b — bactericide; f — fungicide; h — herbicide; i — insecticide; n — nematicide; r — rodenticide; md — mating disrupter; s — slug bait

[2] symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder; **WSP** — watersoluble packets

[3] See Table 12–3, *Ontario pesticide classification schedules*, on page 223. [4] See Table 12–5, *Pest control product companies*, on page 227.

TABLE 12–1. Pesticides used on fruit crops in Ontario (cont'd)

Registration No.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Chemical family or activity group	Formulation[2]	Guaranteed % (active unless stated)	Ont. sch.[3]	Man/ agent's code[4]
	malathion	*see* MALATHION 25 W						
14656	MALATHION 25W	malathion	i	organophosphate	WP	25%	3	UAG
	mancozeb	*see* DIKAR, MANZATE 200 WP, MANZATE 200 DF, DITHANE DG, GAVEL 75DF, PENNCOZEB 75 DF						
21057	MANZATE 200 DF	mancozeb	f	dithiocarbamate	DF	75%	3	GRN, DUQ
10526	MANZATE 200 WP	mancozeb	f	dithiocarbamate	WP	80%	3	GRN
24984	MATADOR 120 EC	cyhalothrin lambda	i	synthetic pyrethroid	EC	120 g/L	5	SYZ
13975	MERTECT SC	thiabendazole	f	benzimidazole	Su	500 g/L	3	SYZ
	metalaxyl + mancozeb	*see* RIDOMIL GOLD MZ 68 WP						
	metalaxyl-m	*see* RIDOMIL GOLD 480 EC						
	metam sodium	*see* VAPAM, BUSAN 1020						
	methomyl	*see* LANNATE						
	metiram	*see* POLYRAM DF						
14653	MICROSCOPIC SULPHUR	sulphur	f	inorganic	WP	92%	6	UAG
873	MICROSCOPIC WETTABLE SULPHUR	sulphur	f	inorganic	WP	92%	6	BAT
	mineral oil	*see* SUPERIOR OIL						
24446	MITAC W	amitraz	i	triazapentadiene	WSP	50%	2	BAT
	myclobutanil	*see* NOVA 40 W						
22399	NOVA 40W	myclobutanil	f	triazole (DMI)	WSP	40%	2	DWE
25547	NUSTAR	flusilazole	f	DMI	DF	20%	2	DUQ
	oxamyl	*see* VYDATE						
25397	PENNCOZEB 75DF	mancozeb	f	dithiocarbamate	WDG	75%	3	EFA
	permethrin	*see* POUNCE						
	pheromone	*see* ISOMATE - GBM , Isomate M-Rosso, Isomate M-100 , Isomate GBM plus						
	phosalone	*see* ZOLONE .						
	phosmet	*see* IMIDAN						
	pirimicarb	*see* PIRIMOR 50 DF						
22792	PIRIMOR 50DF	pirimicarb	i	carbamate	DF	50%	2	SYZ
20087	POLYRAM DF	metiram	f	dithiocarbamate	WDG	80%	3	BAZ, ENG
16565	POUNCE	permethrin	i	pyrethroid	EC	384 g/L	3	UAG, BCZ
	propiconazole	*see* TOPAS 250 E						
25135	PYRAMITE	pyridaben	a,i	pyridazinone	WP	75%	2	BAZ, ENG
	pyridaben	*see* PYRAMITE						

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are captialized.

[1] a — acaracide, miticide; b — bactericide; f — fungicide; h — herbicide; i — insecticide; n — nematicide; r — rodenticide; md — mating disrupter; s — slug bait

[2] symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder; **WSP** — watersoluble packets

[3] See Table 12–3, *Ontario pesticide classification schedules*, on page 223.[4] See Table 12–5, *Pest control product companies*, on page 227.

TABLE 12-1. Pesticides used on fruit crops in Ontario (cont'd)

Registration No.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Chemical family or activity group	Formulation[2]	Guaranteed % (active unless stated)	Ont. sch.[3]	Man/ agent's code[4]
11670	RAMIK BROWN	diphacinone	r		pellets	0.005%	6	UAG,HOK
25384	RIDOMIL GOLD 480 EC	metalaxyl-M	f	acylamine	EC	480 g/L	2	SYZ
25379	RIDOMIL GOLD MZ 68 WP	metalaxyl+ mancozeb	f	acylamine + dithiocarbamate	WP	4% + 64%	2	SYZ
15738	RIPCORD 400 EC	cypermethrin	i	pyrethroid	EC	407 g/L	2	BAZ
24894	RONILAN EG	vinclozolin	f	dicarboximide	DG	50%	3	BAZ
7717	ROPELLANT	thiram	r		Sn	13%	3	UAG, BAT
15213	ROVRAL	iprodione	f	dicarboximide	WP	500 g/L	3	BCZ
	ROZOL	chlorophacinone	r		pellets	—	3,6	UAG, LPH
25343	SENATOR 70 WP	thiophanate-methyl	f	benzimidazole	WP	70%	3	ENG
19531	SEVIN XLR PLUS	carbaryl	i	carbamate	Su	42.8%	3	BCZ
27096	SLUGGO	ferric phosphate	s		Gr	0.76%	-	ENG
23323	SNIPER	azinphosmethyl	i	organophosphate	WSP	50%	5	UAG
26257	SOVRAN	kresoxim-methyl	f	strobilurin	WDG	50%	3	ENG, BAZ
	spinosad	*see* SUCCESS 480 SC						
10305	STREPTOMYCIN 17	streptomycin sulphate	b		WP	25.2%	3	UAG
	streptomycin sulphate	*see* STREPTOMYCIN 17						
26835	SUCCESS 480 SC	spinosad	i	naturalyte	SC	480 g/L	3	DWE
	sulphur	*see* KUMULUS, MICROSCOPIC SULPHUR, MICROSCOPIC WETTABLE SULPHUR, LIME SULPHUR						
9542	SUPERIOR 70 OIL	mineral oil	a,i		Li	98.5%	6	BAT, UAG
	tebufenizide	*see* CONFIRM 240 F						
16324	TELONE C-17	dichloropropene + chloropicrin	b,f,h, i,n		Li	78% + 14%	2	DWE
15893	TELONE II	dichloropropene	n		Li	94%	2	DWE
	thiabendazole	*see* Mertect SC						
15747	THIODAN 4EC	endosulfan	i	chlorinated cyclodiene	EC	400 g/L	2	BCZ
15821	THIODAN 50 WP	endosulfan	i	chlorinated cyclodiene	WP	50%	2	BCZ
15333	THIONEX 50 WP	endosulfan	i	chlorinated cyclodiene	WP	50%	2	UAG, MKA
	thiophanate methyl	*see* SENATOR 70 WP						
24030	TOPAS 250E	propiconazole	f	triazole (DMI)	EC	250 g/L	2	ENG
	tri-basic copper sulphate	*see* COPPER 53 W						
	trifloxystrobin	*see* FLINT WG						

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[1] a — acaracide, miticide; b — bactericide; f — fungicide; h — herbicide; i — insecticide; n — nematicide; r — rodenticide; md — mating disrupter; s — slug bait

[2] symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder; **WSP** — watersoluble packets

[3] See Table 12-3, *Ontario pesticide classification schedules*, on page 223.[4] See Table 12-5, *Pest control product companies*, on page 227.

TABLE 12–1. Pesticides used on fruit crops in Ontario (cont'd)

Registration No.	BRAND or TRADE NAME *	Common name or active ingredient	Use[1]	Chemical family or activity group	Formulation[2]	Guaranteed % (active unless stated)	Ont. sch.[3]	Man/ agent's code[4]
	triforine	*see* FUNGINEX 190 EC						
	thiram	*see* ROPELLANT						
25509	VANGARD 75 WG	cyprodinil	f	anilinopyrimidine	WDG	75%	2	ENG
6453	VAPAM	metam sodium	b,f,h, i,n	Group 27	Sn	380 g/L	3	UAG, AMV
	vinclozolin	*see* RONILAN EG						
17995	VYDATE	oxamyl	i,n	carbamate	Li	240 g/L	5	DUQ
17983	ZOLONE FLO	phosalone	i	organophosphate	Fl	500 g/L	2	BCZ
	zoxamide/mancozeb	*see* GAVEL 75 DF						

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[1] a — acaracide, miticide; b — bactericide; f — fungicide; h — herbicide; i — insecticide; n — nematicide; r — rodenticide; md — mating disrupter; s — slug bait

[2] symbols used are: **DF** — dry flowable; **DG** — dry granules; **DIS** — dispenser units; **EC** — emulsifiable concentrate; **Fl** — flowable; **Gr** — granule; **Li** — liquid; **SC** — soluble concentrate; **Sn** — solution; **Su** — suspension (flowable); **WDG** — water dispersable granule; **WG** — wettable granular; **WP** — wettable powder; **WSP** — watersoluble packets

[3] See Table 12–3, *Ontario pesticide classification schedules*, on page 223.[4] See Table 12–5, *Pest control product companies*, on page 227.

TABLE 12–2. Thinners and growth regulators used on fruit crops in Ontario

Registration No.	BRAND or TRADE NAME*	Common name or active ingredient	Use[1]	Guaranteed % (active unless stated)	Formulation[2]	Ont. Sch.[3]	Man/ Agent's Code[4]
24593	ACCEL	n-(phenylmethyl) -1h-purine-6-amine gibberellins a6a7	PGR, TH	1.8% 0.18%	Sn	3	VBC
11904	ACTIVOL	gibberellic acid	PGR	0.92 g/tablet	tablets	6	N OC
13167	AMID-THIN	1-napthaleneacetamide	PGR, TH	8.3%		6	AMV, UAG
11580	ETHREL	ethephon	PGR	240 g/L	L	6	BCZ
14630	FRUITTONE	1-napthaleneacetic acid	PGR, TH	3.1%		3	AMV, UAG
16636	PROMALIN	benzyladenine gibberellins	PGR	1.8% ba 1.8% ga	Sn	3	VBC
—	SURROUND	kaolin	CP	95%	WP	—	ENG
25609	ReTAIN	aminoethoxy vinyl glycine hydrochloride	PGR	15%	Sp	2	VBC

* Mention of a BRAND or TRADE name does not constitute a guarantee of warranty of the product by the Ontario Crop Protection Committee. All TRADE NAMES are capitalized.

[1] **PGR** — plant growth regulator, **TH** — thinner; **CP** — crop protectant

[2] **L** — liquid; **Sp** — soluble powder; **Sn** — solution; **WP** — wettable powder

[3] See Table 12–3, *Ontario pesticide classification schedules*, on page 223.

[4] See Table 12–5, *Pest control product companies*, on page 227.

TABLE 12-3. Ontario pesticide classification schedules

The Ontario Ministry of the Environment reviews each pesticide product offered for sale in Ontario and classifies it into one of 6 groupings called Schedules.

Schedule	Who Can Use It	Pesticide Characteristics*
1	licensed applicator certified grower only with approved permit	very toxic and/or very persistent and/or highly mobile
5	licensed applicator certified grower assistant agriculturist under supervision	very toxic and/or very persistent and/or highly mobile less toxic or less persistent alternative not available
2	licensed applicator certified grower trainee or technician under supervision (some restrictions apply) assistant agriculturist under supervision	toxic, and/or persistent, and/or moderately mobile
3	licensed exterminator certified grower trainee or technician consumer	moderately toxic, and/or moderately persistent, and/or slightly mobile
4	licensed exterminator certified grower trainee or technician consumer	low toxicity non-persistent non-mobile containers < 1kg < 1l
6	licensed exterminator certified grower trainee or technician consumer	low toxicity non-persistent non-mobile containers > 1 kg > 1l

* Biological persistence and mobility in the environment, as expected under normal use conditions for Ontario.

Certification and Training Requirements: You must be a certified grower or a licensed applicator (exterminator) to buy and use Schedule 1, 2 and 5 pesticides.

Read the label and follow all safety precautions.

Health Canada has established amounts of pesticides that may remain on fruits at time of harvest. To avoid exceeding these tolerances, use recommended amounts and do not spray nearer to harvest than number of days shown below, or not later than stage indicated. For tank mixes of 2 or more materials, use the longest period given for any of the materials. **Be aware that many processors may require longer preharvest intervals than stated on product labels. Contact processors directly regarding their preharvest interval policy. Do not apply a pesticide more often than recommended on label.**

TABLE 12–4. Number of days from last spray to harvest

	Apple	Apricot	Blueberry	Currant & Gooseberry	Cherry	Grape	Peach	Pear	Plum	Raspberry	Saskatoon berries	Strawberry	Tree nuts
ADMIRE 240F	7												
AGRI-MEK 1.9EC	28							28		PH		300	
ALIETTE WDG	30									60		30	
APOLLO SC	A						A, 21			15		15	
ASSAIL 70 WP	7					7		7					
BIOPROTEC CAF	1												
BOTRAN 75W							10						
BRAVO 500			54		40		60					30	
CABRIO EG			29		10							1	
CAPTAN 80 WDG	7	2	2		5*	7	2	7	2	2		2	
CARZOL SP	1						21	1					
CONFIRM 240 F	14												
COPPER 53 W	30					1						1	
COPPER SPRAY													40
CYGON 480-Ag	14		15									7	
CYMBUSH 250 EC	7					7	7	7				7	
DECIS 5EC	1		14				1	7				14	
DIAZINON 50 W	14			PB	10	16			10	PB			
DIAZINON 500 E				PB						PB			
DIKAR	45					30		45					
DIPEL 2X DF	1	1						1		1			1
DITHANE DG	45												
ELEVATE 50 WDG			1	1	1	7	1			1		1	
ENDOSULFAN 50W	15				15	30	15	15	15			7	
EQUAL 65 WP					7			7				7	
FERBAM 76 WDG	7		40	14	4	7	21			PB			
FLINT 50 WG	14					14		14					
FOLPAN 50 WP						1						1	
FORAY 48 BA	1							1		1			
FUNGINEX 190 EC	V		60		PB		PB		PB		60		
FURADAN 480 F												PB	
GUARDSMAN COPPER OXYCHLORIDE													1
GAVEL 75DF						66							

A — within 14 days of petal fall; **PB** - prebloom; **PH** — postharvest; **V** — vegetative or non-bearing year only; **DD** — delayed dormant

* 2 days on sweet cherry

** 1 day on table grapes

TABLE 12–4. Number of days from last spray to harvest (cont'd)

	Apple	Apricot	Blueberry	Currant & Gooseberry	Cherry	Grape	Peach	Pear	Plum	Raspberry	Saskatoon berries	Strawberry	Tree nuts
GUTHION 240 EC						28							
GUTHION SOLUPAK	14/21	21	14		15	28	21	14	15	14			21
IMIDAN 50 WP	1		15		7	7	1	1	1				
INDAR 75 WSP		1			1		1		1				
KELTHANE 50 W	7	14			7	7	14	7	7	7		7	
KUMULUS DF	1				1	21**					1		
LAGON 480 E			15									7	
LANCE WDG		1	0	0	1	14	1		1	0		0	
LANNATE	8												
LIME SULPHUR										DD			
LORSBAN 50 W							21						
MAESTRO 80 DF	7	2	2		5*	7	2	7	2	2		2	
MALATHION 25 W			1	3						1		3	
MANZATE 200 DF	45												
MANZATE 200 WP						30							
MATADOR 120 EC	7						7	7				7	
MICRSCOPIC WETTABLE SULPHUR	1			1		21**	1		1				
MITAC W								14					
NOVA 40 W	14				1	14	1				14		
NUSTAR	77												
PENNCOZEB 75 DF	45												
PIRIMOR 50 DF	35						60						
POLYRAM DF	45					45							
POUNCE	7					21	7	7					
PYRAMITE	25					25	14	25		PH		10	
RIDOMIL GOLD 480 EC	V									V. PH		V. PH	
RIDOMIL GOLD MZ						PB							
RIPCORD 400 EC	7							7				7	
RONILAN EG												3	

A — within 14 days of petal fall; **PB** - prebloom; **PH** — postharvest; **V** — vegetative or non-bearing year only; **DD** — delayed dormant
* 2 days on sweet cherry ** 1 day on table grapes

TABLE 12–4. Number of days from last spray to harvest (cont'd)

	Apple	Apricot	Blueberry	Currant & Gooseberry	Cherry	Grape	Peach	Pear	Plum	Raspberry	Saskatoon berries	Strawberry	Tree nuts
ROVRAL		1			1	7	1		1	1		1	
SENATOR 70 WP										1			
SEVIN XLR PLUS	11	5	2		2	5	1		2				
SLUGGO						0							
SNIPER	14	21	14		15	28	21	14	15	14			
SOVRAN	30					14							
STREPTOMYCIN 17	50							30					
SUCCESS 480 SC	7	14						7					
THIODAN 50 WP	15	15			15	30	15	15	15			7	
THIODAN 4 EC	15	15					15		15			7	
THIONEX 50 WP							15						
TOPAS 250 E		3	60		3		3		3		38		
VANGARD 75 WG	72	2				7	2		2				
VYDATE	V									PH			
ZOLONE FLO	30				14								

A — within 14 days of petal fall; **PB** - prebloom; **PH** — postharvest; **V** — vegetative or non-bearing year only; **DD** — delayed dormant

* 2 days on sweet cherry ** 1 day on table grapes

TABLE 12-5. Pest control product companies

Code*	Registrant or agent	Web site	Contact number
AFG	AEF Global Inc.	www.aefglobal.com	1-418-838-4441
AMV	AMVAC Chemical Corporation	www.ecozin.com (U.S. web site)	
TOA	Arvesta	www.arvesta.com	1-519-766-1117
BAT	Bartlett, N.M. Inc	www.bartlett.ca	1-800-263-1287
BAZ	BASF Canada Inc	www.agsolutions.ca/	1-877-371-2273
BCZ	Bayer CropScience	www.bayercropscience.ca	1-877-938-3737
BUL	Buckman Laboratories of Canada	www.buckman.com	
CUI	Cheminova Canada Inc.	www.cheminova.com/	1-888-316-6260
DUQ	Dupont Canada Inc.	www.dupont.ca/ag	1-800-667-3925
DWE	Dow Agro Science Canada	www.Dowagro.com	1-800-667-3852
EFA	Cerexagri Inc. (Ato fina Canada)	www.cerexagri.com (U.S. web site)	1-905-827-9841
ENG	Engage Agro Corp	www.engageagro.com	1-866-613-3336
GOW	Gowan Company	www.gowanco.com	1-800-883-1844
GRN	Griffin Corp	www.dupont.ca/ag	1-800-667-3925
HOK	Hacco Inc.	www.hacco.com (U.S. web site)	1-608-221-6200
LPH	Lipha Tech	www.liphatech.com (U.S. web site)	1-414-351-1476
MKA	Makhteshim-Agan		1-416-233-1496
NOC	Norac Concepts	www.noracconcepts.com	1-613-841-2907
PBC	Pacific Biocontrol	www.pacificbiocontrol.com (U.S. web site)	1-360-571-2247
SYZ	Syngenta Crop Protection	www.syngenta.ca	1-800-797-5040
UAG	United Agri Products	www.uap.ca	1-800-265-4624
VAR	Univar	www.univarcanada.com	1-800-265-7671
VBC	Valent Biosciences	www.valent.com	1-800-682-5368

* The 3-letter manufacturer's codes represent the codes listed in Table 12-1, *Pesticides used on fruit crops in Ontario*, on page 217 and Table 12-2, *Thinners and growth regulators used on fruit crops in Ontario*, on page 222.

For Canadian labels, contact the registrant, or search the PMRA website at http://www.hc-sc.gc.ca/pmra-arla/english/main/search-e.html

13. Appendices

APPENDIX A. Ontario Ministry of Agriculture and Food Crop Advisory Staff

Brighton Resource Centre **General Phone (613) 475-1630 Fax (613) 475-3835** 95 Dundas St. E RR#3 Brighton, ON K0K 1H0			
IPM Systems Specialist	Margaret Appleby	margaret.appleby @omaf.gov.on.ca	(613) 475-5850
Delhi **General Phone (519) 582-7220 Fax (519) 582-4504** Southern Crop Protection and Food Research Centre Schafer Rd. Box 186 Delhi, ON N4B 2W9			
IPM Specialist – Specialty Crops	Denise Beaton	denise.beaton@omaf.gov.on.ca	(519) 582-7220 ext. 263
Fergus Resource Centre **General Phone (519) 846-0941 Fax (519) 846-8178** RR#1, County Road 18, Wellington Place Fergus, ON N1M 2W3			
Agroforestry Specialist	Todd Leuty	todd.leuty@omaf.gov.on.ca	(519) 846-3390
Harrow **General Phone (519) 738-2251 Fax (519) 738-4564** Greenhouse and Processing Crops Research Centre 2585 County Road 20, Harrow, ON N0R 1G0			
Greenhouse Vegetable IPM Specialist	Gillian Ferguson	gillian.ferguson@omaf.gov.on.ca	(519) 738-2251 Ext. 406
Weed Management – Horticulture Program Lead	Leslie Huffman	leslie.huffman@omaf.gov.on.ca	(519) 738-2251 Ext. 499
Greenhouse Vegetable Specialist	Shalin Khosla	shalin.khosla@omaf.gov.on.ca	(519) 738-2251 Ext. 405
Kemptville Resource Centre **General Phone (613) 258-8295 Fax (613) 258-8392** Box 2004, Concession Rd Kemptville, ON K0G 1J0			
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Agroforestry Specialist	Dave Chapeskie	dave.chapeskie@omaf.gov.on.ca	(613) 258-8302
Field Crops, IPM Program Lead – Bilingual	Gilles Quesnel	gilles.quesnel@omaf.gov.on.ca	(613) 258-8250
Lindsay Resource Centre **General Phone (705) 324-6125 Fax (705) 324-1638** 322 Kent St. W Lindsay, ON K9V 2Z9			
Forage Specialist	Joel Bagg	joel.bagg@omaf.gov.on.ca	(705) 324-5856
London Resource Centre **General Phone (519) 873-4070 Fax (519) 873-4062** 667 Exeter Road London, ON N6E 1L3			
Apple Specialist	John Gardner	john.gardner@omaf.gov.on.ca	(519) 873-4084
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Ridgetown Resource Centre **General Phone (519) 674-1690 Fax (519) 674-1564** Agronomy Building, Ridgetown College Box 400, Main St. E Ridgetown, ON N0P 2C0			
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Simcoe Resource Centre **General Phone (519) 426-7120 Fax (519) 428-1142** P.O. Box 587 Blueline Rd & Hwy #3 Simcoe, ON N3Y 4N5			
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Berry Crop Specialist	Pam Fisher	pam.fisher@omaf.gov.on.ca	(519) 426-2238
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Ginseng and Medicinal Herbs Specialist	Jan Schooley	jan.schooley@omaf.gov.on.ca	(519) 426-4323
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Stratford Resource Centre **General Phone (519) 271-0280 Fax (519) 273-5278** 581 Huron St. Stratford, ON N5A 5T8			
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Biosolids Specialist	Michael Payne	michael.payne@omaf.gov.on.ca	(519) 271-4496
Soil Fertility Specialist	Keith Reid	keith.reid@omaf.gov.on.ca	(519) 271-9269
Soybean Specialist	Horst Bohner	horst.bohner@omaf.gov.on.ca	(519) 271-5858
Thunder Bay **General Phone (807) 475-1373 Fax (807) 475-1219** 335 Euclid Ave., Thunder Bay, ON P7E 6G6			
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Vineland Resource Centre **General Phone (905) 562-4147 Fax (905) 562-5933** Adv. Serv. Building, Box 8000, 4890 Victoria Avenue, North Vineland Station, ON L0R 2E0			
Tender Fruit and Grape Specialist	Ken Slingerland	ken.slingerland@omaf.gov.on.ca	(905) 562-1639
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Entomology, Horticulture Program Lead	Hannah Fraser	hannah.fraser@omaf.gov.on.ca	(905) 562-1674
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Nutrient Management Field Crops Program Lead	Christine Brown	christine.brown@omaf.gov.on.ca	(519) 537-8305
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Marketing and Communications Officer	Vacant		(519) 826-3150 (fax) 826-3259
Apiary Specialist	Doug McRory	doug.mcrory@omaf.gov.on.ca	(519) 826-3595 fax (519) 826-3567
Product Development Specialist	Kelly Ward	kelly.ward@omaf.gov.on.ca	(519) 826-4094 fax (519) 826-4964
Vegetable Crops Specialist	Kristen Callow	kristen.callow@omaf.gov.on.ca	(519) 826-4963 fax (519) 826-4964
On-Farm Food Safety Program Lead	Sandra Jones	sandra.jones@omaf.gov.on.ca	(519)826-3289 fax (519)826-4964
Organic Crop Production Program Lead	Hugh Martin	hugh.martin@omaf.gov.on.ca	(519) 826-4587 fax: (519)826-4964
Minor Use Coordinator	Jim Chaput	jim.chaput@omaf.gov.on.ca	(519) 826-3539 fax (519) 826-4964
Applied Research Co-ordinator	Lindsay Arthur	lindsay.arthur@omaf.gov.on.ca	(519) 826-7456 fax (519) 826-3567
Potato Specialist Food Science Building	Dr. Eugenia Banks	eugenia.banks@omaf.gov.on.ca	(519) 826-3678 fax (519) 826-4964
University of Guelph **General Phone (519) 824-4120** 50 Stone Road East Guelph, ON N1G 2W1			
Turfgrass Specialist, Guelph Turfgrass Institute 328 Victoria Rd S R. R. # 2 Guelph, ON N1H 6H8	Pam Charbonneau	pamela.charbonneau@omaf.gov.on.ca	(519) 824-4120 Ext. 2597 fax (519) 766-1704
Pathologist — Horticulture Crops Program Lead Edmund Bovey Building	Michael Celetti	michael.celetti@omaf.gov.on.ca	(519) 824-4120 Ext. 8910 fax (519) 767-0755
Nursery Crops Specialist Edmund Bovey Building	Jennifer Llewellyn	jennifer.llewellyn@omaf.gov.on.ca	(519) 824-4120 Ext. 2671 fax (519) 767-0755
Nutrition — Horticulture Program Lead Land Resource Science, Richards Building	Christoph Kessel	christoph.kessel@omaf.gov.on.ca	(519) 824-4120 Ext. 2480 fax (519) 824-5730
Weed Management Field Crops Program Lead Crop Science Building	Mike Cowbrough	mike.cowbrough@omaf.gov.on.ca	(519) 824-4120 ext. 2580 fax (519) 763-8933
Applied Research Coordinator – Field Crops Crop Science Building	Ian McDonald	ian.mcdonald@omaf.gov.on.ca	(519) 824-4120 Ext. 6707 fax (519) 763-8933
Corn Industry Program Lead Crop Science Building	Greg Stewart	greg.stewart@omaf.gov.on.ca	(519) 824-4120 Ext. 4865 fax (519) 763-8933

Agricultural Information Contact Centre

General Phone (877) 424-1300 or (519) 826-4047 Fax (519) 826-7610

Provides province-wide, toll-free technical and business information to commercial farms, agri-businesses and rural businesses.

1 Stone Road, West Guelph ON N1G 4Y2 e-mail: *ag.info@omaf.gov.on.ca*

Government Information Centre in Guelph

Staff Directories - Phone 1-888-466-2372 or (519) 826-3100
1 Stone Road West Guelph ON N1G 4Y2

APPENDIX B. Accredited Soil Testing Laboratories in Ontario

The following labs are accredited to perform soil tests for pH, buffer pH, P, K, Mg and Nitrate-N on Ontario soils.

Laboratory Name	Address	Telephone/Fax/e-mail	Contact
A & L Canada Laboratories East, Inc.	2136 Jetstream Road London, Ont. N5V 3P5	tel: (519) 457-2575 fax: (519) 457-2664 e-mail: aginfo@al-labs-can.com web site: www.al-labs-can.com	Greg Patterson Ian McLachlin
Accutest Laboratories	146 Colonnade Road, Unit #8 Nepean, Ont. K2E 7Y1	tel: (613) 727-5692 fax: (613) 727-5222 e-mail: phaulena@accutestlabs.com web site: www.accutestlabs.com	Lorna Wilson Peter Haulena
Agri-Food Laboratories	503 Imperial Road, Unit #1 Guelph, Ont. N1H 6T9	tel: (519) 837-1600 1-800-265-7175 fax: (519) 837-1242 e-mail: lab@agtest.com web site: www.agtest.com	Dale Cowan Nora Wilson
Brookside Laboratories, Inc.	301 South Main Street New Knoxville, Ohio 45871	tel: (419) 753-2448 fax: (419) 753-2949 e-mail: nfisher@blinc.com	Nicole Fisher Mark Flock
Soil and Nutrient Laboratory	University of Guelph P.O. Box 3650, 95 Stone Road West, Guelph, Ont. N1H 2W1	tel: (519) 767-6226 fax: (519) 767-6240 e-mail: vkerslak@lsd.uoguelph.ca	Virginia Kerslake
Stratford Agri Analysis (A Daco Laboratories Ltd.)	1131 Erie St., Box 760 Stratford, Ont. N5A 6W1	tel: (519) 273-4411 1-800-323-9089 fax: (519) 273-4411 e-mail: saa@dacolabs.com	Dale Peters Keith Lemp

There is no official accreditation in Ontario for tissue analysis, but all of the accredited soil testing labs are monitored for proficiency on tissue analysis.

APPENDIX C. Ontario Ministry of the Environment Pesticides Control Offices

Region/County	Address	Telephone/Fax
Central Region Toronto, Halton, Peel, York, Durham	5775 Yonge Street, 8th Floor Toronto, Ont. M2M 4J1	tel (416) 326-6700 toll free 1-800-810-8048 fax (416) 325-6347
West-Central Region Haldimand-Norfolk, Niagara, Hamilton-Wentworth, Dufferin, Wellington, Waterloo, Brant	Ontario Government Building 119 King Street West, 12th Floor Hamilton, Ont. L8P 4Y7	tel (905) 521-7640 toll free1-800-668-4557 fax (905) 521-7820
Eastern Region Frontenac, Hastings, Lennox & Addington, Prince Edward, Leeds & Grenville, Prescott & Russell, Stormont/Dundas & Glengarry, Peterborough, Victoria, Northumberland, Renfrew, Ottawa-Carleton, Lanark, District of Nipissing (Townships of Airy, Murchison, Dickens, Lyell and Sabine)	133 Dalton Avenue Kingston, Ont. K7L 4X6	tel (613) 549-4000 toll free 1-800-267-0974 (in Eastern region only) fax (613) 548-6908
Southwestern Region Elgin, Middlesex, Oxford, Essex, Kent, Lambton, Bruce, Grey, Huron, Perth, Simcoe	659 Exeter Road, 2nd Floor London, Ont. N6E 1L3	tel (519) 873-5000 toll free1-800-265-7672 fax (519) 873-5020
Northern Region East Manitoulin, Nipissing, Parry Sound, Sudbury, Algoma East, Cochrane East, Haliburton, Muskoka	199 Larch Street, Suite 1101 Sudbury, Ont. P3E 5P9	tel (705) 564-3249 fax (705) 564-4180
Northern Region West Kenora, Rainy River, Thunder Bay, Algoma West, Cochrane West	435 James St. S., Suite 331 Thunder Bay, Ont. P7E 6S7	tel(807) 475-1712 toll free1-800-875-7772 fax(807) 475-1754
Standards Development Branch	Pesticides Section 40 St. Clair Avenue West, 7th Floor Toronto, Ont. M4V 1M2	tel (416) 327-5519 fax (416) 327-2936
Approvals Branch	Pesticides Licensing 2 St. Clair Avenue West, 12A Floor Toronto, Ont. M4V 1L5	tel (416) 314-8001 toll free 1-800-461-6290 fax (416) 314-8452

APPENDIX D. Other Contacts

UNIVERSITY OF GUELPH

Main Campus
Guelph, N1G 2W1
(519) 824-4120
www.uoguelph.ca

Alfred College
Alfred, K0B 1A0
(613) 679-2218
www.alfredc.uoguelph.ca/

Kemptville College
Kemptville, K0G 1J0
(613) 258-8336
www.kemptvillec.uoguelph.ca

Ridgetown College
Ridgetown, N0P 2C0
(519) 674-1500
www.ridgetownc.on.ca

Department of Plant Agriculture
www.plant.uoguelph.ca

Department of Plant Agriculture
Kettleby
1125 Woodchopper's Lane, R.R. # 1
Kettleby, L0G 1J0
(905) 775-3783

Department of Plant Agriculture,
Simcoe
Box 587 Blue Line Rd.
Simcoe, N3Y 4N5
(519) 426-7127

Department of Plant Agriculture,
Vineland
Box 7000, 4890 Victoria Ave. N.
Vineland Station, L0R 2E0
(905) 562-4141

Lab Services Division
www.uoguelph.ca/labserv/

Pesticide and Trace Contaminants
P.O. Box 3650, 95 Stone Rd. W.
Guelph, N1H 8J7
(519) 767-6200

Pest Diagnostic Clinic
95 Stone Rd. W.
Guelph, N1H 8S7
(519) 767-6256
www.uoguelph.ca/pdc

AGRICULTURE & AGRI-FOOD CANADA

Research Centres

Eastern Cereals and Oilseeds Research Centre
960 Carling Avenue, Ottawa, K1A 0C6
(613) 759-1952
http://res2agr.ca/ecorc/index_e.htm

Greenhouse and Processing Crops Research Centre
Harrow, N0R 1G0
(519) 738-2251
http://res2.agr.ca/harrow/

Southern Crop Protection and Food Research Centre
http://res2.agr.ca/london/pmrc/pmrchome.html

1391 Sandford St.
London, N5V 4T3
(519) 457-1470

Vineland Research Farm
4902 Victoria Ave. N.
Vineland, L0R 2E0
(905) 562-4113

Delhi Research Farm
Box 186 Schafer Rd.
Delhi, N4B 2W9
(519) 582-1950

CANADIAN FOOD INSPECTION AGENCY

www.cifa-acia.agr.ca

Regional Offices (Plant Protection)

Belleville
345 College St. E.
Belleville, K8N 5S7
(613) 969-3333

Brantford
Federal Building, Dalhousie & Queen St.
P.O. Box 637
Brantford, N3T 5P9
tel (519) 751-8157

Hamilton
709 Main St. W., 101
Hamilton, L8S 1A2
(905) 572-4152

London
1200 Commissioners Rd. E., Unit 19
London, N5Z 4R3
(519) 691-1300

Niagara Falls
(Mailing address)
R.R #1 P.O. Box #7
Niagara on the Lake, L0S 1J0
(Street address)
14154 Niagara River Parkway, Unit # 5
Niagara on the Lake
(905) 262-5331

Ottawa District
3 Observatory Crescent, Bldg. #3 Central
Experimental Farm, Ottawa, K1A 0C9
(613) 759-1571

Toronto Office
401 Champagne Dr., Unit 1
Downsview, M3J 2C6
(416) 954-1714

Windsor
441 University Ave. W., Suite 208
Windsor, N9A 5P9
(519) 252-7095

AGRICORP (Crop Insurance)

Customer Action Centre
1-888-AGRI-999
(1-888-247-4999)
P.O. Box 3660, Station Central
Guelph, N1H 8M4
www.agricorp.com

APPENDIX E. Diagnostic Service

Samples for disease diagnosis, insect or weed identification, nematode counts and *Verticillium* testing can be sent to:

Pest Diagnostic Clinic
Laboratory Services Division
University of Guelph
95 Stone Rd. W.
Guelph Ont.ario, N1H 8J7
tel: (519) 767-6256
fax: (519) 767-6240
e-mail: pdc@lsd.uoguelph.ca

Payment must accompany samples at the time of submission. Submission forms are available at *www.uoguelph.ca/pdc*.

Fee Schedule

To obtain information on the fee schedule, refer to *www.uoguelph.ca/pdc* or phone the Pest Diagnostic Clinic.

How to Sample for Nematodes

Soil

When to sample

Soil and root samples can be taken at any time of the year that the soil is not frozen. In Ontario, nematode soil population levels are generally at their highest in May and June and again in September and October.

How to sample soil

Use a soil sampling tube, trowel or narrow-bladed shovel to take samples. Sample soil to a depth of 20–25 cm (8–10 in.). If the soil is bare, remove the top 2 cm (1 in.) prior to sampling. A sample should consist of 10 or more subsamples combined. Mix well. Then take a sample of $^1/_2$–1 L (1 pint–1 quart) from this. No one sample should represent more than 2.5 ha (6.25 ac). Mix subsamples in a clean pail or plastic bag.

Sampling pattern

If living crop plants are present in the sample area, take samples within the row and from the area of the feeder root zone (with trees, this is the drip line).

Number of subsamples

Based on the total area sampled:

500 m^2 (5,400 ft^2)	10 subsamples
500 m^2–0.5 ha (5,400 ft^2–1.25 ac)	25 subsamples
0.5 ha–2.5 ha (1.25–6.25 ac)	50 subsamples

Roots

From small plants, sample the entire root system plus adhering soil. For large plants, 10–20 g ($^1/_2$–1 oz.) dig fresh weight from the feeder root zone and submit.

Problem areas

Take soil and root samples from the margins of the problem area where the plants are still living. If possible, also take samples from healthy areas in the same field. If possible, take both soil and root samples from problem and healthy areas in the same field.

Sample handling

Soil samples

Place in plastic bags as soon as possible after collecting.

Root samples

Place in plastic bags and cover with moist soil from the sample area.

Storage

Store samples at 5°C–10°C (40°C–50°F) and do not expose them to direct sunlight or extreme heat or cold (freezing). **Only living nematodes can be counted. Accurate counts depend on proper handling of samples.**

Submitting Plant for Disease Diagnosis or Identification

Sample submission forms

Forms can be obtained from your local Ontario Ministry of Agriculture and Food office. Carefully fill in all of the categories on the form. In the space provided, draw the most obvious symptom and the pattern of the disease in the field. It is important to include the cropping history of the area for the past 3 years and this year's pesticide use records.

Choose a complete, representative sample showing early symptoms. Submit as much of the plant as is practical, including the root system, or several plants showing a range of symptoms. For turfgrass, submit a 10–15 cm^2 piece of turf, including thatch and at least 5 cm of soil. Take the sample from the outside edge of a ring or patch, and include healthy and unhealthy turf, as well as the interface between. If symptoms are general, collect the sample from an area where they are of intermediate severity. Completely dead material is usually inadequate for diagnosis.

With plant specimens submitted for identification, include at least a 20–25-cm sample of the top portion of the stem with lateral buds, leaves, flowers or fruits in identifiable condition. Wrap plants in newspaper and put in a plastic bag. Tie the root system off in a separate plastic bag to avoid drying out and contamination of the leaves by soil. Do **NOT** add moisture, as this encourages decay in transit. Cushion specimens and pack in a sturdy box to avoid damage during shipping. Avoid leaving specimens to bake or freeze in a vehicle or in a location where they could deteriorate.

Delivery

Deliver to the Pest Diagnostic Clinic as soon as possible by first class mail or by courier at the beginning of the week.

Submitting Insect Specimens for Identification

Collecting samples

Place dead, hard-bodied insects and spiders in vials or boxes and cushion with tissues or cotton. Place soft-bodied insects and caterpillars in vials containing alcohol. Do not use water, as this results in rot. Do not tape insects to paper or send them loose in an envelope.

Place live insects in a container with enough plant "food" to support them during transit. Be sure to write "live" on the outside of the container.

UNIVERSITY of GUELPH LABORATORY SERVICES

95 Stone Road West
Guelph, ON N1H 8J7
Tel: (519) 767-6256
Fax: (519) 767-6240
Web: www.uoguelph.ca/pdc

Pest Diagnostic Clinic

SAMPLE SUBMISSION FORM

LABORATORY USE ONLY: **LS Form: SubP01/04/03**

Rec'd: By:____________ **Date Received:** ____________

Delivered By: ☐ **Mail** ☐ **Courier** ☐ **In-Person**

LS Sample No: ____________ **to** ____________

Payment Rec'd: $____________ **Receipt #:**____________

Submitted By:			Owner (if different from submitter):		
Business Name (if applicable):			Business Name (if applicable):		
Street:			Street:		
City:	Prov:	Postal Code:	City:	Prov:	Postal Code:
Tel: ( ) -	Fax: ( ) -		Tel: ( ) -	Fax: ( ) -	
Email:			Email:		

Unless otherwise indicated, report and invoice will be sent to submitter

Report to: ☐ Submitter ☐ Owner   Required Report Format: ☐ Fax ☐ E-Mail ☐ Mail

Invoice to: ☐ Submitter ☐ Owner Quotation #: ________   Purchase Order / U of G G/L code:____________

Services Required: ☐ Nematode Count ☐ Nematode Count from Roots ☐ SCN Cyst & Egg Count ☐ Verticillium Count ☐ Plant Disease Diagnosis ☐ Insect Identification ☐ Plant Identification ☐ Triazine Resistance Test

Plant or Host Affected:		Cultivar/Variety:	Grower/Field sample #:
		Location of Plant (i.e. greenhouse, field, orchard, garden, etc.):	
Size of Planting:	% of Plants Affected:	Symptoms First Appeared in Past: ☐ Days ☐ Weeks ☐ Months ☐ Years	Degree of Injury: ☐ Severe ☐ Moderate ☐ Light
Cropping History:		Future Crop:	

Describe the problem in detail (i.e. symptoms, plant parts affected, distribution of symptoms):

Were chemicals applied? Please specify type of product(s) used and date(s) of application:

Additional comments and specific requests:

Additional Sheet(s) Attached: ☐

APPENDIX F. Suppliers of Pest Monitoring Equipment and Biological Control Agents

This is a partial list of suppliers of IPM monitoring equipment, including weather monitoring equipment, pest monitoring supplies, and biological control agents. Inclusion in this list does not imply endorsement or recommendation by the Ontario Ministry of Agriculture and Food. For a more extensive list of suppliers, see the OMAF web site at *www.omaf.gov.on.ca* for a list of beneficial insects and mites suppliers and pest monitoring equipment suppliers

Company	Address	Phone/Fax	E-mail/web site	Products
Boibest Canada Ltd.	2020 Mersea Rd. #3 R.R. #4 Leamington, ON N8H 3V7	tel: (519) 322-2178 fax: (519) 322-1271 *toll free fax:* 1-888-472-0708	info@biobest.ca www.biobest.ca	beneficial insects, mites, nematodes, insect traps and pheromones
Cooper Mill Ltd.	R. R. # 3 Madoc, ON K0K 2K0	tel: (613) 473-4847 fax: (613) 473-5080	ipm@coopermill.com www.coopermill.com	pheromone lures and traps
Gempler's	1210 Fourier Drive, Suite 150 Madison, WI 53717	tel: 1-800-382-8473 fax: 1-800-551-1128	www.gemplers.com	weather monitoring equipment pheromone lures and traps apple maggot spheres tangle trap magnifiers tally counters
Great Lakes IPM	10220 Church Rd., NE Vestaburg, MI 48891	tel: (989) 268-5693 fax: (989) 268-5311	glipm@nethawk.com www.greatlakesipm.com	apple scab monitoring equipment pheromone lures and traps apple maggot spheres tangle trap magnifiers tally counters insect sweep nets field diagnostic equipment
Koppert Canada Limited	50 Ironside Cres., #2 Scarborough, ON M1X 1G4	tel: (416) 291-0040 fax: (416) 291-0902	pgoodspeed@koppert.ca www.koppert.com	beneficial insects, mites
Natural Insect Control	R. R. # 2 Stevensville, ON L0S 1S0	tel: (905) 382-2904 fax: (905) 382-4418	nic@niagara.com www.naturalinsectcontrol.com	beneficial insects, mites and nematodes pheromone lures and traps mating disruption devices bird houses
Phero Tech Inc.	7572 Progress Way Delta, BC V4G 1E9	tel: (604) 940-9944 fax: (604) 940-9433	sales@pherotech.com www.pherotech.com	pheromone lures and traps
Plant Products Co. Ltd.	314 Orenda Rd. E. Brampton, ON L6T 1G1	tel: 1-800-387-2449 fax: (905) 793-9632	sales@plantprod.com www.plantprod.com	beneficial insects and mites magnifiers
N.M. Bartlett Inc.	4509 Bartlett Rd. Beamsville, ON L0R 1B1	tel: (905) 563-8261 fax: (905) 563-7882	info@bartlett.ca www.bartlett.ca	pheromone lures and traps
Solida Distributors	480, rg. St-Antoine St. Ferreol-les-Neiges, QC, G0A 3R0	tel: (418) 826-0900 fax: (418) 826-0901	solida@clic.net	pheromone traps and lures tangle trap magnifiers tally counters apple maggot spheres
Warwick Orchards and Nursery	R. R. # 8 Watford, ON N0M 2S0	tel: (519) 849-6730 fax: (519) 849-6731	warwick@xcelco.on.ca	dewit leaf wetness sensor

APPENDIX G. Crop Insurance

The Canada-Ontario Crop Insurance Program is publicly funded by the Government of Canada and the Province of Ontario and delivered by AGRICORP. The Federal and Provincial governments each contribute 25% of the premium cost and 50% of the administrative costs. Both these contributions enable an Ontario grower to purchase insurance coverage at a substantially reduced cost.

The grower's payment is considered an operating expense for income tax purposes. Crop insurance offers protection against a broad range of production hazards, including excessive rain, hail, excessive drought, freeze, frost, excessive wind and certain insects and diseases.

For further information, please call AGRICORP's Customer Action Centre at 1-888-AGRI-999 (1-888-247-4999).

AGRICORP
1 Stone Rd. W.
Box 3660, Station Central
Guelph, Ontario N1H 8M4
tel: (519) 826-3276
fax: (519) 826-4118
web site: www.agricorp.com

Ontario Crops Covered by a Crop Insurance Plan		
Fruit Crops		
apples (fruit and/or trees)	cherries, sweet and sour	grapes (fruit and/or vines)
peaches	pears	plums
strawberries		
Vegetable Crops		
asparagus	beets (processing)	broccoli
butternut squash (processing)	cabbages	carrots (fresh)
carrots (processing)	cauliflower	celery
cucumbers (processing)	green beans and wax beans (processing)	lettuce
lima beans (processing)	parsnips	peas (processing)
peppers	potatoes	rutabagas
seed onions	set onions	Spanish onions
sweet corn (fresh)	sweet corn (processing)	tomatoes (processing)
tomatoes (fresh)		
General Crops		
canola	corn (grain and silage)	coloured beans
forage	honey	industrial hemp
new forage seeding	peanuts	popping corn
red spring wheat	seed corn	spring grain
soybeans	sugarbeets	sunflower
wheat, winter	white beans	
Tobacco		
black	flue-cured	

APPENDIX H. OMAF Factsheets and Publications Available for Fruit Growers

Only paid publications have a price listing. All others are free. To order, call 1-877-424-1300 or visit the OMAF web site, product catalogue at *www.omaf.gov.on.ca*.

Title	Order No.	Price
Horticultural Crops		
Bird Control on Grape & Tender Fruit Farms	98-035	
Deer Control Practices in Agriculture	Pub. 10	
Land Preparation: A Key To Successful Soil Fumigation	89-177	
Leaf Analyses For Fruit Crop Nutrition	91-012	
Mite Pests And Their Predators In Ontario Orchards	95-057	
Sizing And Laying Out A Short-Term (Summer) Refrigerated Storage For Fruits & Vegetables	92-124	
Soil Management For Orchards And Vineyards	92-120	
Storage Incompatibility	86-091	
Troubleshooting Cold Storage Problems	94-083	
Tree Fruit (Apples and Tender Fruit)		
Apple Rootstocks	00-007	
Apricot Cultivars	02-035	
Bacterial Canker of Sweet Cherry	88-086	
Beneficial Insects in Tree Fruit Orchards in Southern Ontario	96-029	
Bitter Pit Control In Apples	00-009	
Black Knot Of Plums	91-046	
Controlled Atmopshere Storage Guidelines and Recommendations for Apples	03-073	
Cherry Cultivars - Sweet and Tart	02-037	
Comstock Mealy Bug On Peach	83-076	
Crabapple Pollenizers For Apples	00-011	
Disease Resistant Apple Cultivars	98-013	
Establishment and Production Costs for Tender Fruit in Ontario — 2002 Economic Report	Pub. 817	$10
Evaluating Maturity Of McIntosh And Red Delicious Apples	00-025	
Evaluating Maturity of Empire, Idared and Spartan Apples	00-027	
Fire Blight of Apple and Pear in Ontario	02-011	
Fruit Trees in the Home Garden	98-011	
Guide for Spraying Fruit Trees	00-035	
Harvesting and Handling Apples	00-003	
What you Should Know About Fruit Production in Ontario	03-081	
Insect and Mite Pests of Apple in Ontario	92-051	
Integrated Pest Management for Ontario Apple Orchards	Pub. 310	$40
Introduction to High Density Apple Orchard Management	Pub. 711	
Irrigation Scheduling for Fruit Crops	90-069	
Mating Disruption for Management of Insect Pests	03-079	
Orchard Grafting Methods	98-005	
Peach and Nectarine Cultivars	02-033	
Peach Leaf-Curl	83-071	
Pear Cultivars	02-039	
Pear Psylla In Ontario Pear Orchards	90-101	
Plum Cultivars – European and Japanese	02-041	
Predatory Insects in Fruit Orchards	Pub. 208	$15
Producing Quality Empire Apples	00-013	
Pruning Fruit Trees	00-005	
Repair Grafting	98-003	
Rodent & Deer Control in Orchards	98-023	

Title	Order No.	Price
Scale Insect Pests Of Tree Fruit	90-120	
Sharka (Plum Pox Virus) of Stone Fruit and Ornamental Prunus Species	02-001	
Susceptibility of Ontario Grown Apples to Scald in C.A.	00-029	
Training and Pruning Apple Trees	Pub. 814	$10
Berries		
Blueberries For Home Gardens	90-046	
Currants and Gooseberries	98-095	
Dayneutral Strawberries	89-099	
Elderberries for Home Gardens	95-005	
Growing Red Raspberries in Ontario	Pub. 105	$5
Growing Strawberries in Ontario (incl. colour poster of common strawberry diseases)	Pub. 513	$20
Major and Minor Pests of Strawberry	92-137	
Raspberries and Blackberries For Home Gardens	99-033	
Strawberry Clipper Weevil: A Major Pest Of Strawberry	99-031	
Tarnished Plant Bug: A Major Pest Of Strawberry	92-108	
Grapes		
Downy Mildew Of Grape (Pest Management Program for Grape Series)		
Establishment and Production Costs for Grapes in Ontario, 2001 Economic Report	Pub. 813	$10
Grape Diseases: Corky Bark Disease and Stem Pitting	93-027	
Grape Phylloxera	88-125	
Insect & Disease Identification Guide for Grapes	03-039	
Phomopsis Cane and Leaf Spot of Grapes	90-123	
Nut Crops		
Nut Culture In Ontario	Pub. 494	$5
Fertility and Soil Management		
Determining the Phosphorus Index for a Field	03-109	
Soil Fertility Handbook	Pub. 611	$35
Management Of Organic Soils	93-053	
Phosphorus (P) And Potassium (K) Soil Testing And Fertilizer Recommendation System in Ontario	97-005	
Weeds — Control		
Field Bindweed	01-007	
Canada Fleabane	02-067	
Cocklebur	01-005	
Guide to Weed Control 2004-2005	Pub. 75	$10
Herbicide Mode of Action Categories	00-061	
Herbicide Resistant Weeds	01-023	
Jerusalem Artichoke	94-077	
Ontario Weeds	Pub. 505	$15
Pigweeds	01-009	
Poison-Ivy	99-015	
Prickly Lettuce	03-041	
Proso Millet	87-025	
Wild Mustard	03-043	
Wirestem Muhly	87-051	

APPENDIX I. Best Management Practices Booklets and Ordering Information

What is a "best management practice?"

A practical, affordable approach to conserving a farm's soil and water resources without sacrificing productivity.

Who decides what qualifies as a best management practice?

Team of farmers, researchers, extension staff and agri-business professionals.

BMP #	Title
BMP 00	A First Look
BMP 01	Farm Forestry & Habitat Management
BMP 02	Field Crop Production
BMP 05	Nutrient Management
BMP 06	Soil Management
BMP 07	Water Management
BMP 08	Irrigation Management
BMP 09	Integrated Pest Management
BMP 10	Fish & Wildlife Habitat Management
BMP 11	No-Till: Making it Work
BMP 12	Water Wells
BMP 13	Pesticide Storage, Handling and Application
BMP 14	Nutrient Management Planning

How Do I Obtain a Book?

- If you're an Ontario farmer, single copies of each title are available at no cost at your local office of the Ontario Ministry of Agriculture and Food.
- Contact the Ontario Federation of Agriculture, 416-485-3333.
- Otherwise, and for single copies, bulk orders, and complete sets of books and related materials, see the Best Management Practices Order Form. Prices vary per title and with quantity ordered
- Selected publications are available on-line, in varying degrees of completeness. See *www.omaf.gov.on.ca* and search by best management.

APPENDIX J. The Metric System

Metric Units

Linear Measures (length)

10 millimetres (mm) = 1 centimetre (cm)
100 centimetres (cm) = 1 metre (m)
1,000 metres = 1 kilometre (km)

Square Measures (area)

100 m x 100 m = 10,000 m^2 = 1 hectare (ha)
100 ha = 1 square kilometre (km^2)

Cubic Measures (volume)

Dry Measure

1,000 cubic millimetres (mm^3) = 1 cubic centimetre (cm^3)
1,000,000 cm^3 = 1 cubic metre (m^3)

Liquid Measure

1,000 millilitres (mL) = 1 litre (L)
100 L = 1 hectolitre (hL)

Weight-Volume Equivalents (for water)

(1.00 kg) 1,000 grams = 1 litre (1.00 L)
(0.50 kg) 500 g = 500 mL (0.50 L)
(0.10 kg) 100 g = 100 mL (0.10 L)
(0.01 kg) 10 g = 10 mL (0.01 L)
(0.001 kg) 1 g = 1 mL (0.001 L)

Weight Measures

1,000 milligrams (mg) = 1 gram (g)
1,000 g = 1 kilogram (kg)
1,000 kg = 1 tonne (t)
1 mg/kg = 1 part per million (ppm)

Dry Liquid Equivalents

1 cm^3 = 1 mL
1 m^3 = 1000 L

Metric Conversions

5 mL = 1 tsp
15 mL = 1 tbsp
28.5 mL = 1 fl. oz.

Application Rate Conversations

Metric to Imperial (Approximate)

litres per hectare x 0.09 = gallons per acre
litres per hectare x 0.36 = quarts per acre
litres per hectare x 0.71 = pints per acre
millilitres per hectare x 0.015 = fluid ounces per acre
grams per hectare x 0.015 = ounces per acre
kilograms per hectare x 0.89 = pounds per acre
tonnes per hectare x 0.45 = tons per acre

Imperial to Metric (Approximate)

gallons per acre x 11.23 = litres per hectare (L/ha)
quarts per acre x 2.8 = litres per hectare (L/ha)
pints per acre x 1.4 = litres per hectare (L/ha)
fluid ounces per acre x 70 = millilitres per hectare (mL/ha)
tons per acre x 2.24 = tonnes per hectare (t/ha)
pounds per acre x 1.12 = kilograms per hectare (kg/ha)
ounces per acre x 70 = grams per hectare (g/ha)

Liquid Equivalents

Litres/Hectare		*Approximate Gallons/Acre*
50 L/ha	=	5 gal./acre
100 L/ha	=	10 gal./acre
150 L/ha	=	15 gal./acre
200 L/ha	=	20 gal./acre
250 L/ha	=	25 gal./acre
300 L/ha	=	30 gal./acre

Dry Weight Equivalents

Grams or Kilograms / Hectare		*Ounces or Pounds / Acre*
100 g/ha	=	1 1/2 oz./acre
200 g/ha	=	3 oz./acre
300 g/ha	=	4 1/4 oz./acre
500 g/ha	=	7 oz./acre
700 g/ha	=	10 oz./acre
1.10 kg/ha	=	1 lb./acre
1.50 kg/ha	=	1 1/4 lb./acre
2.00 kg/ha	=	1 3/4 lb./acre
2.50 kg/ha	=	2 1/4 lb./acre
3.25 kg/ha	=	3 lb./acre
4.00 kg/ha	=	3 1/2 lb./acre
5.00 kg/ha	=	4 1/2 lb./acre
6.00 kg/ha	=	5 1/4 lb./acre
7.50 kg/ha	=	6 3/4 lb./acre
9.00 kg/ha	=	8 lb./acre
11.00 kg/ha	=	10 lb./acre
13.00 kg/ha	=	11 1/2 lb./acre
15.0 kg/ha	=	13 1/2 lb./acre

Conversion Tables — Metric to Imperial

Length

1 millimetre (mm) = 0.04 inch
1 centimetre (cm) = 0.40 inch
1 metre (m) = 39.40 inches
1 metre (m) = 3.28 feet
1 metre (m) = 1.09 yards
1 kilometre (km) = 0.62 mile

Area

1 square centimetre (cm^2) = 0.16 square inch
1 square metre (m^2) = 10.77 square feet
1 square metre (m^2) = 1.20 square yards
1 square kilometre (km^2) = 0.39 square mile
1 hectare (ha) = 107,636 square feet
1 hectare (ha) = 2.5 acres

Volume (dry)

1 cubic centimetre (cm^3) = 0.061 cubic inch
1 cubic metre (m^3) = 1.31 cubic yards
1 cubic metre (m^3) = 35.31 cubic feet
1,000 cubic metres (m^3) = 0.81 acre-foot
1 hectolitre (hL) = 2.8 bushels

Volume (liquid)

1 millilitre (mL) = 0.035 fluid ounce
1 litre (L) = 1.76 pints
1 litre (L) = 0.88 quart
1 litre (L) = 0.22 gallon (Imp.)
1 litre (L) = 0.26 gallon (U.S.)

Weight

1 gram (g) = 0.035 ounce
1 kilogram (kg) = 2.21 pounds
1 tonne (t) = 1.10 short tons
1 tonne (t) = 2,205 pounds

Pressure

1 kilopascal (kPa) = 0.15 pounds/in.^{2}

Speed

1 metre per second = 3.28 feet per second
1 metre per second = 2.24 miles per hour
1 kilometre per hour = 0.62 mile per hour

Temperature

°F = (°C X 9/5) + 32

Conversion Tables — Imperial to Metric

Length

1 inch = 2.54 cm
1 foot = 0.30 m
1 yard = 0.91 m
1 mile = 1.61 km

Area

1 square foot = 0.09 m^2
1 square yard = 0.84 m^2
1 acre = 0.40 ha

Volume (dry)

1 cubic yard = 0.76 m^3
1 bushel = 36.37 L

Volume (liquid)

1 fluid ounce (Imp.) = 28.41 mL
1 pint (Imp.) = 0.57 L
1 gallon (Imp.) = 4.55 L
1 gallon (U.S.) = 3.79 L

Weight

1 ounce = 28.35 g
1 pound = 453.6 g
1 ton = 0.91 tonne

Pressure

1 pound per square inch = 6.90 kPa

Temperature

°C = (°F – 32) x 5/9

Handy Metric Conversion Factor

Litres per hectare x 0.4 = litres per acre
Kilograms per hectare x 0.4 = kilograms per acre

Abbreviations

% = per cent (by weight)
ai = active ingredient
AP = agricultural powder
cm = centimetre
cm^2 = square centimetre
DG = dispersible granular
DP = dispersible powder
E = emulsifiable
e.g. = for example
EC = emulsifiable concentrate
F = flowable
g = gram
Gr = granules, granular
ha = hectare
kg = kilogram
km/h = kilometres per hour
kPa = kilopascal
L = litre
m = metre
m^2 = square metre
mL = millilitre
mm = millimetre
m/s = metres per second
SC = sprayable concentrate
SP = soluble powder
t = tonne
W = wettable (powder)
WDG = water dispersible granular
WP = wettable powder

Spraying Record

Crop or Field No.	Date	Material Used	Rate or Amount	Weather and Soil Conditions

Emergency and First-Aid Procedures for Pesticide Poisoning

For a major spill, a theft or a fire involving a pesticide call the Ministry of the Environment at **1-800-268-6060**.

For pesticide poisonings and pesticide injuries call the **Poison Information Centre:**

Toronto	1-800-268-9017
Ottawa (Bilingual)	1-800-267-1373
Hearing Assistance (TTY)	1-877-750-2233

PREVENT ACCIDENTS

- **Read the label.** Follow all the precautions the label recommends. Read the First Aid section of the label BEFORE you begin to handle any pesticide.
- **Make sure that someone knows** what pesticides you are working with and where you are.
- **Keep a file of labels and product Material Safety Data Sheets (MSDS) for the pesticides you use**. Make sure everyone knows where to find this in case of an emergency.
- **Post emergency numbers near all telephones.**
- **Keep clean water, paper towels, extra gloves and clean coveralls close by** in case you spill pesticide on yourself.

If someone has been working with pesticides and you see any possible symptoms of pesticide poisoning or injury, take emergency action immediately.

IF AN ACCIDENT OR POISONING HAPPENS

- Protect yourself from injury first.
- Stop the exposure to the pesticide. Move the victim away from the contaminated area.
- Check the 4 basic facts — identify the pesticide, the quantity, the route of entry and time of exposure.
- Call an ambulance or the Poison Information Centre.
- Start first aid. This is **not** a substitute for professional medical help.
- **Provide the label, MSDS sheet or container to emergency personnel** at the scene — or take it with you to the hospital. Do not transport pesticide containers in the passenger compartment of the vehicle.

FIRST AID

If a pesticide comes in contact with skin:

- remove all contaminated clothing; wash skin thoroughly with lots of soap and warm water
- dry skin well and cover with clean clothing or other clean material.

If pesticide comes in contact with eyes:

- hold eyelids open wash the eyes with clean running water for 15 minutes or more.

If pesticide was inhaled:

- move the victim to fresh air and loosen tight clothing
- give artificial respiration if the victim is not breathing.

Do not breathe in the exhaled air from the victim — you could also be poisoned.

If a pesticide was swallowed:

- **call the Poison Information Centre IMMEDIATELY.**

Emergency numbers are listed at the front of each Bell telephone directory.

For information, or to obtain copies of this or any other ministry publication please:

call 1-888-466-2372 from within Ontario, (519) 826-3700 from outside the province or OMAF's TTY line at (519) 826-7402 for the hearing impaired, email your request to *products@omaf.gov.on.ca*, or visit OMAF's web site at *www.omaf.gov.on.ca*.

A complete list of all OMAF products and services, and order forms, are available on the web site. Orders can be faxed to (519) 826-3633 or mailed to Government Information Centre, 1 Stone Road West, Guelph, Ontario N1G 4Y2.

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